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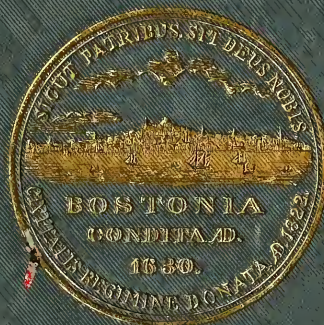


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Boston Transit Commission.

Third Annual Report.



August 15, 1897.



No

6355.4



1897
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Estate of James B. Noyes



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FROM

THE BOSTON TRANSIT COMMISSION,
20 Beacon Street.

GEORGE G. CROCKER, *Chairman,*
CHARLES H. DALTON,
THOMAS J. GARGAN,

GEORGE F. SWAIN,
HORACE G. ALLEN,
Commissioners.

HOWARD A. CARSON,
Chief Engineer.

B. LEIGHTON BEAL,
Secretary.

THIRD ANNUAL REPORT

OF THE

BOSTON TRANSIT COMMISSION,

FOR THE YEAR ENDING

AUGUST 15, 1897.



BOSTON :
PRESS OF ROCKWELL AND CHURCHILL.
1897.



* 6355, 4
Vol. 3 1897 - Repl.

Estate of James B. Noyes
Dec. 30, 1949

BOSTON TRANSIT COMMISSION.

20 BEACON STREET,
BOSTON, Aug. 16, 1897.

TO THE CITY COUNCIL OF THE CITY OF BOSTON:

In compliance with Statutes of 1894, chapter 548, section 24, the report of the Boston Transit Commission for the year ending Aug. 15, 1897, is respectfully submitted.

PROGRESS OF WORK ON THE SUBWAY.

The work on the subway during the past year has progressed satisfactorily. Full details will be found in the accompanying report of the Chief Engineer, Mr. Howard A. Carson.

In general it may be stated that the subway is substantially completed, with the exception of the section in Scollay square, the section in Adams square, and the section north of Haymarket square. The Scollay-square and Adams-square sections are in process of construction. The section north of Haymarket square has not yet been contracted for.

The Commission has delayed the plans and contracts for the construction of the latter section on account of the possibility that changes in the plans would be required in accordance with the provisions of the Acts of 1897, chapter 500, section 12, in case the Boston Elevated Railway Company should construct its road as authorized. The completion of this section may be delayed in consequence of such changes, although the work of construction will be comparatively easy, since the section is located upon the land of the old Boston & Maine station, and the work will therefore be free from the peculiar complications incident to work under streets and near the foundations of buildings.

The portion of the subway extending from the entrances in the Public Garden and at Pleasant street to Park street is substantially ready for use, and is being equipped by the West End Street Railway Company with tracks and electrical apparatus. In the Appendix will be found a statement furnished by the West End Street Railway Company regard-

ing the progress of this work of equipment, which is now nearly completed.

The Commission expected to be able to complete the construction of the entire subway in the spring of 1898, but the necessary delays above referred to in connection with the northern terminal will probably extend the time.

As required by law the portion of the subway under streets and squares has been constructed without seriously incommoding traffic between the hours of 8 A.M. and 6 P.M., the work being carried on continuously night and day.

THE COMPLETION OF SECTIONS ONE, TWO, AND THREE.

On August 13th notice of the following vote was sent to the West End Street Railway Company :

Voted, In accordance with the provisions of a contract between the city of Boston, acting by the Boston Transit Commission, and the West End Street Railway Company, for the use of the subway, dated Dec. 7, 1896, a notification be sent to said company, that, in the judgment of the Commission, that portion of the subway from the entrance on the Public Garden to Park street, known as Sections 1, 2, and 3 and a part of Section 3½, can be advantageously used before the completion of the whole subway, and said portion of the subway having been completed, the Commission has determined that, allowing a reasonable time to the party of the second part for the completion of the equipment thereof, the use of such portion shall begin on the first day of September next.

At the time when this notice was sent the West End Street Railway Company had practically completed the laying of tracks in the sections named, and had equipped said sections with electric light and power apparatus, and the date of the beginning of occupation was fixed with the approval of the company.

STATIONS ON TREMONT-STREET MALL OF THE COMMON.

The stations at the junction of Tremont and Boylston streets and at Park street have been completed in the manner described in the last annual report of the Commission. The walls are lined with white porcelain brick or tile. The steel columns are encased in concrete, and painted white like the brickwork and the exposed steelwork of the roof. The staircase coverings were designed by Messrs. Wheelwright & Haven, architects, and built by Messrs. Norcross Bros., contractors. They are of classic design, with walls of Deer Isle granite, lined with white porcelain brick, with glass roofs, and with patent safety treads on the stairs.



THE HEILOTYPING CO., BOSTON

N. L. STEBBINS, PHOTOGR.

SECTION 5. -- FOUR-TRACK INCLINE, PLEASANT STREET, TREMONT STREET, SHAWMUT AVENUE.

These stations and stairways, if fully utilized, are believed to be sufficient to accommodate a much larger traffic than the present, and will meet the extraordinary demands of holidays to a reasonable degree. No steam or electric railway, ferry, or other public conveyance, no building, sidewalk, or street, is ever planned to fully accommodate a holiday crowd. To do so, aside from its financial extravagance, would entail great inconvenience to the public in the normal use of the premises.

The act provides that the subway shall not extend under the Common more than sixty feet beyond the limit of the malls. The stations have been made as wide as possible under this provision.

COMMON AND PUBLIC GARDEN.

In previous reports reference has been made to the raising of the surface on the low parts of the Common and Public Garden by depositing thereon the surplus earth taken from the subway excavation. This work is now finished, except the seeding of the northwestern corner of the Common, which has been delayed until the coming autumn at the request of His Honor the Mayor.

On the Boylston-street mall the gravel sidewalk has been replaced and widened to 25 feet. On the Tremont-street mall a granolithic walk 25 feet wide with a grass border on each side has replaced the former gravel walk.

LIGHTING THE SUBWAY.

By the contract for the use of the subway the West End Street Railway Company is required to light the subway suitably and adequately and to the satisfaction of the Commission. The method of lighting, as set forth in the following letter of E. K. Turner, Civil Engineer, acting in behalf of the company, was, on May 20th, approved by the Commission :

BOSTON, May 17, 1897.

HOWARD A. CARSON, ESQ., CHIEF ENGINEER, *Boston Transit Commission* :

Arrangements for lighting in subway, Sections 1, 2, and 3.

DEAR SIR :

In the Boylston-street portion three rows will be arranged in series of five, alternately, so that if one series goes out every other light will be burning. In the four-track portion the lights will go out only one at a time, each independent of the other. The Boylston-street portion has three rows, one on each side and one over the centre. In the four-track portion each pair of tracks has the same arrangement as the Boylston street. The power for all these incandescents will be furnished from

the central power station, with an automatic switch throwing in the current from the Dorchester station if anything interrupt the central power. After the lights are in operation to Scollay square the Cambridge station will also be connected, making three independent sources of power, either of which will be thrown on automatically if the other is disabled.

At the stations arc lights are to be used. For those shown with a double cross on blue-print of West End roll 1066 the power will be received from Edison or Boston Electric. For those marked with a single cross, on the same plan, the power will be furnished the same as for the incandescent lights; so that if all the power of the West End road gives out there will still be lights enough for people to get around with comfort. The arc lights will be so arranged in series that every alternate light will be extinguished when there is light enough to dispense with them.

The wiring is to be carried back of the knee braces.

(Signed)

Yours truly,

E. K. TURNER,

Per A. B. C.

EXPLOSION AT THE CORNER OF BOYLSTON AND TREMONT STREETS.

On the 4th of March, at 11.46 in the forenoon, at the corner of Boylston and Tremont streets, an explosion occurred, resulting from a leakage of gas into an excavation between the top of the subway and the temporary bridge upon which the street cars and other surface traffic were carried. Six persons lost their lives at the time, and four died afterward. Several others were hurt. The subway structure was not injured. The damage to adjacent buildings consisted principally in the breakage of glass.

The inquest was conducted by a justice of the Municipal Court, and continued from the 12th of March to the 2d of April. On the 24th of April the justice made his report, giving a statement of the circumstances of the accident and his findings thereon.

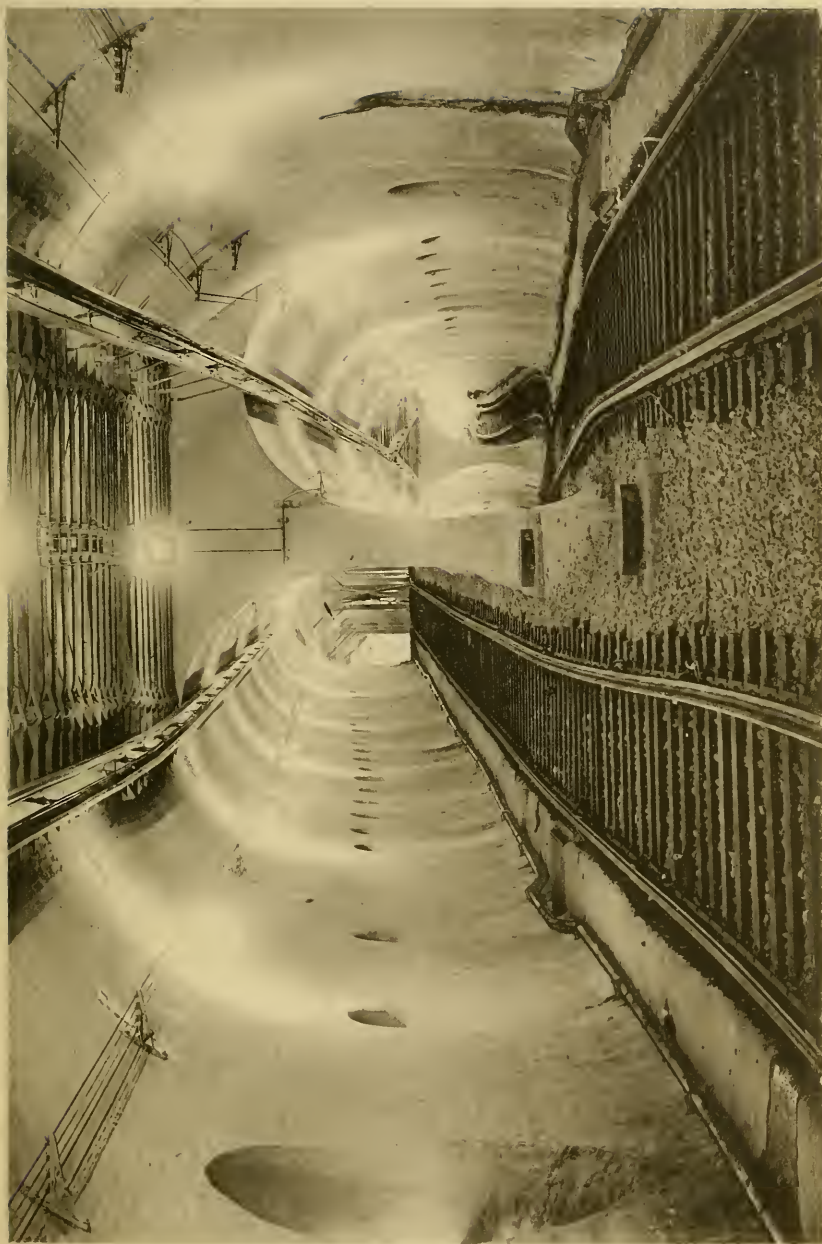
On the 16th of March the Legislature ordered the State Board of Gas and Electric Light Commissioners to make an official public inquiry into the causes of the explosion. After an extended investigation that Board made report, under date of June 4, 1897.

The State Fire Marshal, as required by law, investigated the "causes, origin, and circumstances" of the fire which resulted from the explosion, and made his report under date of March 4, 1897.

Reference is made to the foregoing official documents.

SURFACE TRAFFIC.

On the 7th and 8th of May, 1897, from 6 A.M. to midnight, and on the 10th of May, from 5 P.M. to 8 P.M., a record



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BOSTON TRANSIT COMMISSION

SECTION 4. BELLMOUTHS NEAR HOLLIS STREET UNDER TREMONT STREET, LOOKING SOUTHERLY.
PASSAGE OF SOUTH-BOUND SHAWMUT-AVENUE TRACK UNDER NORTH-BOUND TREMONT-STREET TRACK.

of the passage of cars in each direction was taken at the following points, namely: Winter street, Tremont street at Pleasant, Shawmut avenue at Pleasant, Dudley street (Shawmut-avenue line), and Church street. Relays of men stationed at these points noted the time of the passage of each car, describing the car sufficiently for identification. From these entries, in number about 40,000, the time taken by each car in passing between the above-named points was calculated and the results averaged for each hour and each day. Full details regarding these records will be found in the Appendix. The following is a condensed statement of the results obtained:

The distance between Winter street and Church street is 2,880 feet.

Quickest trip,	2m. 40s.	which is at the rate of	12.27	miles per hour.
Slowest	" 12m. 23s.	" " " "	2.64	" "
Average	" 6m. 27s.	" " " "	5.07	" "

The distance between Winter street and Tremont street at Pleasant is 2,840 feet.

Quickest trip,	2m. 45s.	which is at the rate of	11.73	miles per hour.
Slowest	" 13m. 55s.	" " " "	2.31	" "
Average	" 6m. 10s.	" " " "	5.23	" "

The distance between Winter street and Shawmut avenue at Pleasant street is 2,910 feet.

Quickest trip,	2m. 30s.	which is at the rate of	13.22	miles per hour.
Slowest	" 10m. 49s.	" " " "	3.05	" "
Average	" 6m. 04s.	" " " "	5.45	" "

The distance between Shawmut avenue at Pleasant street and Dudley street is 9,400 feet.

Quickest trip,	6m. 59s.	which is at the rate of	15.30	miles per hour.
Slowest	" 18m. 00s.	" " " "	5.93	" "
Average	" 11m. 24s.	" " " "	9.37	" "

The distance between Winter street and Dudley street is 12,310 feet.

Quickest trip,	11m. 53s.	which is at the rate of	11.78	miles per hour.
Slowest	" 25m. 55s.	" " " "	5.40	" "
Average	" 17m. 37s.	" " " "	7.94	" "

The distance from Winter street to the Union Station and return to Winter street is 8,430 feet.

Quickest trip,	15m. 06s.	which is at the rate of	6.36	miles per hour.
Slowest	" 30m. 45s.	" " " "	3.12	" "
Average	" 21m. 46s.	" " " "	4.41	" "

The slowest trips are made when the most people are travelling and the quickest trips are made when the fewest people are travelling. The number of people who suffer the disadvantages of the trips which are slower than the average is much greater than the number of people who enjoy the advantages of the trips which are quicker than the average.

LEGISLATION OF 1897.

The Legislature of the present year enacted a law entitled, "An Act to Promote Rapid Transit for the City of Boston and Vicinity." Acts of 1897, chapter 500.

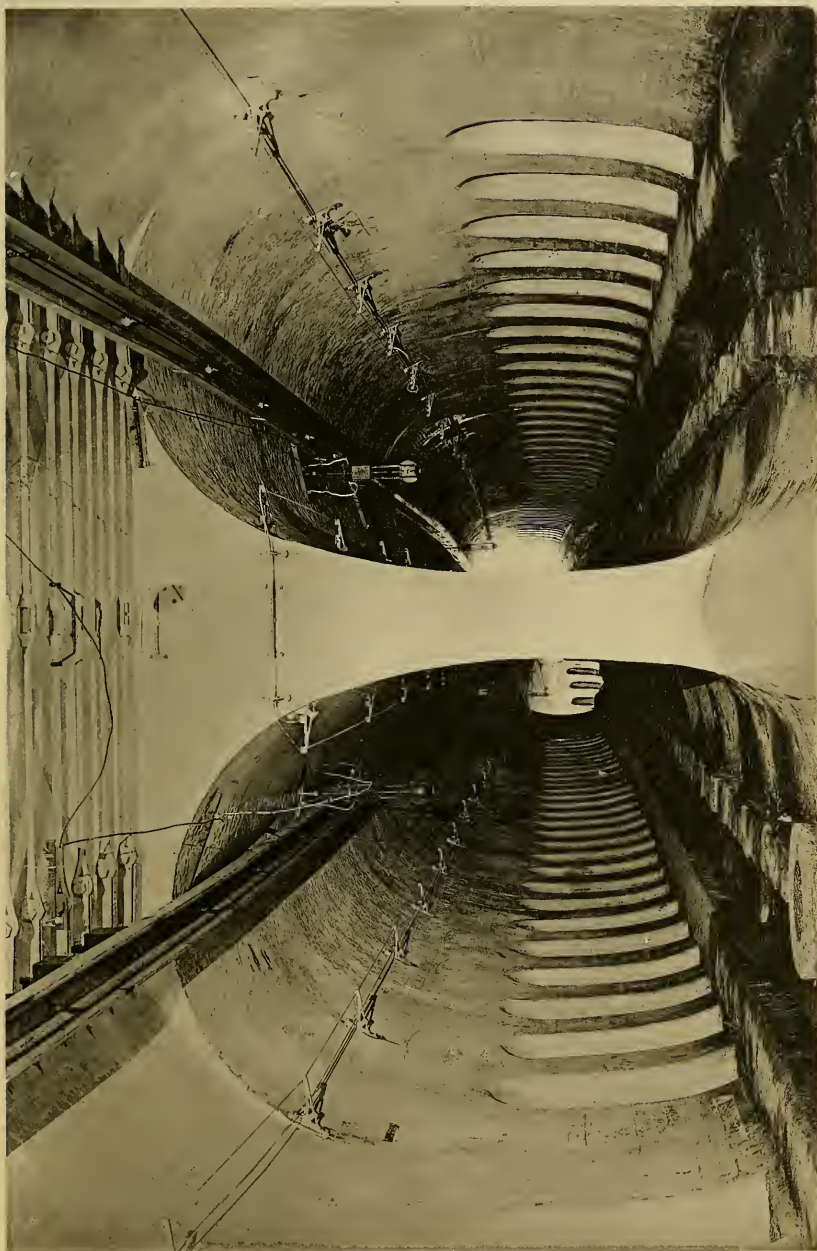
This Act amended "An Act to incorporate the Boston Elevated Railway Company and to Promote Rapid Transit in the City of Boston and Vicinity" (Acts 1894, chapter 548), by giving to the said company additional powers and locations, and otherwise. A copy of said Act will be found in the Appendix.

Section 5 of said Act requires the Boston Transit Commission or the city of Boston, upon the request of said corporation and its compliance with certain requirements, to construct a subway under or near Cambridge street, and under Bowdoin square and Court street to connect with the subway now being constructed.

The cost of any land necessarily taken to maintain Cambridge street at a width of thirty feet on each side of the entrance of such subway shall be paid by the corporation. Section 10 provides for a fare of five cents for a period of twenty-five years.

Section 11 authorizes the corporation to lease and operate the lines, property, etc., of the West End Street Railway Company and other street railway or elevated companies, said leases being subject to the approval of the Board of Railroad Commissioners.

Section 12 of the Act provides that said corporation shall not construct, maintain, and operate its railroad in the subway now in process of construction unless said West End Street Railway Company shall assign to it all its rights, powers, and privileges under its contract for the use of the subway. In case of such assignment the Boston Transit Commission is required to make such alterations in the subway and approaches thereto as may be necessary to render the same suitable for the running of cars through the same in connection with the elevated structure. The cost of such alterations and approaches shall be considered as part of the cost of the subway under the existing contract with the West End Street Railway Company. The



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BOSTON TRANSIT COMMISSION

INTERIOR OF SECTION 4. BELLMOUTH AND DOUBLE-BARREL SUBWAY, NEAR VAN RENSSELAER PLACE, UNDER TREMONT STREET, LOOKING NORTHERLY.

Commission is also required to so construct the bridge across Charles river as to safely support an elevated railway thereon.

Section 17 provides that when said corporation is authorized to begin the construction of its railroad over the route first applied for, the Boston Transit Commission shall construct a tunnel or tunnels of sufficient size for two railway tracks, with sidings, etc., from a point on or near Hanover street in the city of Boston or such other point or points as the Commission may deem proper for suitable connection with the subway to a point at or near Maverick square in that part of Boston called East Boston where a suitable connection with surface tracks may be made, and upon the completion thereof the Commission is required to execute a lease in writing to said corporation for the exclusive use thereof for a term expiring twenty-five years from the date of the passage of the act, at an annual rental equal to three-eighths of one per cent. of the gross receipts for each year ending September 30th, of all lines owned, leased, or operated by said corporation. The city is to keep the tunnel watertight, and is to collect from each person passing through the tunnel a toll of one cent, subject to certain limitations.

Section 18 provides that to meet the expenditures authorized by the Act the Treasurer of the city shall from time to time, on the request of the Commission, issue and sell bonds to the amount required to pay the cost of the subway under Cambridge street and of the alterations in the subway required under the lease made by the Commission with the West End Street Railway Company, and further to the amount of \$500,000, in addition to the seven millions authorized by the Acts of 1894, chapter 548; all of which issues are to be outside of the limit of indebtedness of the city.

The preliminary requirements not having been complied with, no action has been taken by the Commission under the foregoing provisions.

The Commission has no authority to pass upon the expediency of building a tunnel to East Boston, but is required to construct such a tunnel when the Elevated Company is authorized to begin the construction of its road. By reference to the last annual report it will be seen that the Chief Engineer estimated the cost of building the tunnel from a convenient point near Hanover street in Boston to Maverick square in East Boston at two million four hundred and six thousand six hundred (2,406,600) dollars. The cost of connecting the subway with this tunnel, as required by the Act of 1897, has never been estimated, but such connection, built to avoid crossings at grade, would necessarily involve

the expenditure of a large amount. If the subways now in process of construction should be built for their estimated cost, viz., five million dollars, there would be a balance of two million dollars, from which must be deducted the value of such portion of the real estate taken by the Commission between Haverhill and Canal streets as is used by the city of Boston, for the widening of those streets or other public purposes. (Statutes 1895, chapter 440, section 5; Statutes 1897, chapter 347.) The amount of the residue of the original appropriation of seven million dollars is, therefore, at this time uncertain. Such residue, with the five hundred thousand dollars appropriated by the Act of 1897, would be used for the following purposes:

1. To pay for the East Boston tunnel.
2. To pay for the connection of such tunnel with the present subway.

It is apparent that the amount appropriated will be insufficient for these purposes.

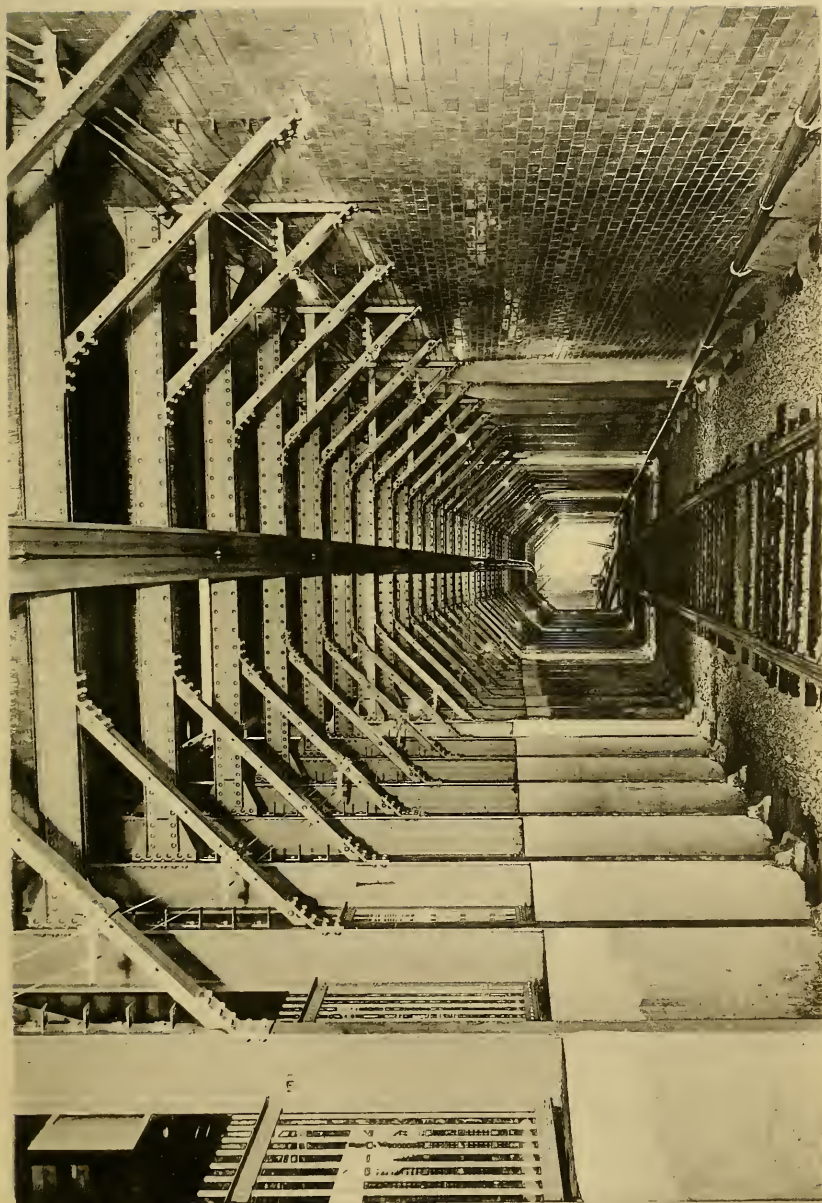
The annual rental to be paid for the East Boston tunnel and its connection, of three-eighths of one per cent. of the gross receipts of the Elevated Railroad Company, based upon the gross earnings of the West End Street Railway Company for the year 1895-6 would be thirty-one thousand two hundred eighty-two and thirty-four hundredths (31,282.34) dollars, or about one per cent. upon three million dollars. The toll of one cent per passenger will necessarily be taken from the passenger toll receipts of the ferries, except in so far as the total passenger traffic between the city and East Boston may be increased by building the tunnel.

CONTRACT FOR THE USE OF THE SUBWAY.

Negotiations with the West End Street Railway Company for the use of the subway, which were pending at the date of the last report, were continued during the fall, and on the 7th day of December, 1896, a contract between the city of Boston, acting by the Boston Transit Commission, and the West End Street Railway Company, was duly executed by the parties; and on the 1st of January, 1897, approved by the Board of Railroad Commissioners. A copy of the contract and the approval will be found in the Appendix.

The following is an abstract of the principal provisions of the contract:

The Grant. — There is granted to the West End Street Railway Company, subject to certain restrictions and limitations, the entire use and occupation of the subway, constructed and to be constructed under the subway acts, the same to be used only for locations of the railway tracks



BOSTON TRANSIT COMMISSION

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SECTION 2.--BOSTON COMMON. DESCENT OF SUB-SUBWAY TOWARDS HOTEL PELHAM,
LOOKING SOUTHERLY.

of said company for the operation of its railway, and for certain cognate purposes expressly enumerated in the contract.

Use of Tracks. — The company may permit the use of its tracks to any street railway now using and entitled by virtue of an existing contract to use its tracks.

Assignment of Contract. — The company may assign its rights, privileges, and powers under the contract to any corporation having the right to carry passengers in the city of Boston which by authority of law succeeds by purchase, lease, or otherwise to the property, rights, and franchises of the company, on condition that such succeeding corporation assumes all the duties, obligations, and undertakings imposed upon the company by the contract.

The Term. — The term of the grant is for twenty years, from the date when the use of any portion of the subway begins.

The Compensation. — The compensation per annum to be paid in quarterly payments is a sum equal to $4\frac{1}{2}$ per cent. of seven million dollars, or $4\frac{1}{2}$ of the net cost of the subway if such net cost shall be less than seven million dollars. It is also provided that the compensation for any quarter of a year after the company shall have acquired the use of all portions of the subway shall not be less than a sum computed by charging a toll of five cents for each passage through the subway of a car not exceeding 25 feet in body length, and a proportionately greater charge for cars of greater length, it being understood that any car which enters or passes through the subway or a portion thereof in one direction and then reverses its direction within the subway and makes a round trip is to be considered as making two passages.

Equipment. — The company is required to equip the subway with tracks, wires, appliances, fixtures, machinery, furniture, and apparatus adapted thereto and necessary for the convenient maintenance and operation of a railway therein, and for the safety and accommodation of the passengers upon said railway.

Power. — The power to be used for the operation of the railway within the subway and of all apparatus placed therein is limited to electricity, compressed air, or some agent, the use of which will not be accompanied by smoke, steam, or noxious products. The use of steam or animals within the subway as a motive power, except temporarily in cases of emergency, is prohibited.

Light. — The company is required suitably and adequately and to the satisfaction of the Commission to light the subway and the cars running therein, by electricity or such other non-explosive illuminant as may be approved by the Commission.

Repairs. — The company is required to maintain the subway in good condition, and to make all repairs necessary therefor at its sole cost and expense, except such repairs as are made necessary by the act of God, public enemies, mobs, riots, the falling or settling of buildings, bursting of pipes outside the subway, explosions of gas, or works of excavations carried on or permitted by the city or other public authority, or by the location, maintenance, or use of such wires or other appliances as the city, under a reserved right, may maintain in the subway.

Removal of Surface Tracks. — The company agrees that it will make no claim against the city for damages for removing, upon the order of the Commission, its surface tracks from Tremont street between Boylston street and Scollay square, and from Boylston street between Park square and Tremont street, and such other tracks as the Commission may order to be removed under the authority of the aforesaid acts; provided that during the term of the contract the right to lay, maintain, and use tracks on the locations from which the tracks are so removed be not granted nor permitted to any other person or corporation for street railway purposes. The company agrees at its own expense to restore and leave in good condition the pavement of that portion of the streets from which the tracks are removed.

Sanitary Requirements. — The company agrees to keep the subway clean, dry, pure, and in good condition, and the stations and the approaches thereto free from ice and snow.

Advertisements and Booths. — Advertising within the subway on the walls or otherwise is prohibited; but the company is permitted to place and maintain booths of suitable size and character upon each platform for the sale of newspapers, magazines, periodicals, and books, so far as the Commission has the power to make such grant.

Liability for Damages. — The company, after the use of the subway by it has begun, assumes all liability for damages of any description resulting from defects in the subway, whether structural or arising out of want of repair or from any cause except such as are enumerated under the head of "Repairs."

Changes in the Subway. — Provision is made determining the conditions under which changes in the subway may be made by the company and by the Commission.

Wires, Conduits, and Tubes. — The right is reserved to the city to place in the subway such wires and apparatus as may be necessary for its police and fire alarm service, and the company has power, under certain limitations, to grant to any person or corporation authorized by law the right to use and maintain for purposes other than railway business, wires, conduits for wires, and pneumatic tubes within the subway.

Provision for Future Action. — The Board of Railroad Commissioners is constituted the authority, after the termination of the existence of the commission and until some other tribunal shall be designated by law for such purpose, to take action in sundry matters arising under the contract.

Operation Subject to General Street Railway Laws. — It is expressly provided that any company running cars within the subway shall, with respect to the operation of the same, have all the powers and privileges and be subject to all the duties, liabilities, restrictions, and provisions set forth in the general laws now or hereafter in force relating to street railways and in any other laws which are or may be applicable to the company so operating, so far as the same are not inconsistent with the provisions of the contract.

Default, Termination of Contract, and Indemnity. — Under certain conditions of default on the part of the company the city has the right to terminate the contract and repossess itself of the subway, and in such case the company agrees to indemnify the city for any loss which it may in any manner sustain by reason of such termination during the residue of the term of twenty years.

It is estimated that the compensation to be paid annually, being $4\frac{7}{8}$ per cent. of the net cost of the subway, will be sufficient to meet the annual interest on, and sinking-fund requirements of, the bonds which have been issued for the construction of the subway. Those bonds run for a term of forty years. Some of them are 4 per cent. bonds and some are $3\frac{1}{2}$ per cent. bonds, and they have been issued at various premiums, which premiums have been paid into the Sinking Fund. The average rate at which the money for the construction of the subway has thus far been borrowed by the city is less than $3\frac{1}{2}$ per cent., leaving about $1\frac{3}{8}$ per cent. to provide for sinking-fund requirements.

From the beginning, the general and detailed plans of

the subway have been open to the officials of the West End Street Railway Company for examination and criticism, and many conferences have been held with those officials. Their recommendations have been adopted by the Commission and the advice received has been of great value. All of the plans for stations, platforms, etc., together with the general dimensions and methods of construction, were approved by the company before they were adopted by the Commission.

At the time the contract was executed, about one-half the total work of building the subway had been done. General plans for the remainder of the work, together with details for stations, platforms, entrances, etc., had been adopted by the Commission, and most of the work was under contract. The company did not request any alterations to be made in the plans of the Commission, it being provided in the contract that the subway should be constructed similarly to the portions already completed and substantially according to the route and with the stations indicated on a plan prepared by the Chief Engineer of the Commission and forming a part of the contract.

CHARLESTOWN BRIDGE.

The work of building the new bridge to Charlestown has been prosecuted during the past year, without interruption. Ten masonry piers are now nearly completed, and it is expected that, by the last of October, they will be ready for the steel superstructure, at which time the two abutments will also be completed.

The steel for eight spans has been contracted for, and the erection of the superstructure will probably begin about the first of November. The plans for three sections of masonry at the Charlestown end of the bridge are being prepared with a view to issuing, in October, proposals for doing this work. It is the intention to build the draw foundation and the draw pier during the coming winter, and to have the plans for the remainder of the work completed, so that all remaining contracts may be made in the early spring.

THE COMMISSION.

On the 4th of November, 1896, owing to business engagements conflicting with his work as Commissioner, Mr. Albert C. Burrage tendered his resignation to His Honor Lieut.-Gov. Roger Wolcott, Acting Governor. On November 19th this resignation was accepted. On the same date Mr. Horace G. Allen was appointed to fill the vacancy, and on November 24th the appointment was confirmed by the Council, and Mr. Allen was duly qualified.

PAYMENTS TO SINKING FUND.

The following premiums on bond issues and receipts from all sources have been paid into the Rapid Transit Sinking Fund during the year, not including income from investments :

On Subway Account.

1896.

Nov.	Premium on \$1,500,000 $3\frac{1}{2}$ per cent. bonds	\$24,375 00
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1897.

Mar. 27	For advertising privileges	200 00
May 10	Rentals of Haymarket sq. property, ...	3,631 09
May 26	For advertising privileges	30 00
June 22	“ “ “ “	15 00
July	Premium on \$1,000,000 $3\frac{1}{2}$ per cent. bonds	26,750 00
		\$55,001 09

On Charlestown Bridge Account.

1897.

May 10	For rentals of Charlestown Bridge property	\$2,245 92
July	Premium on \$500,000 $3\frac{1}{2}$ per cent. bonds	13,375 00
		<u>\$15,620 92</u>

Condition of the Sinking Fund to date, including interest on investments :

Subway	\$244,839 78
Charlestown Bridge	16,062 42

STATEMENT OF EXPENSES.

The following is a classified statement of the expenses of the Commission for the year ending Aug. 15, 1897 :

SUBWAY.

General Expenses :

Office — Repairs	\$58 00
Furniture	116 25
Supplies	1,098 78
Stationery and printing	2,016 38
Fuel and light	205 25
Rental	1,500 00

Carried forward,

\$4,994 66

THIRD ANNUAL REPORT.

15

<i>Brought forward,</i>	\$4,994 66	
Stenographers	2,768 75	
Messenger	780 00	
Clerks	380 00	
Janitor	209 30	
Salaries of Commissioners and Secretary	27,998 99	
Total	\$37,131 70	
General Expenses: 4-5 to Subway		\$29,705 36

ENGINEERING DEPARTMENT.

Rooms — Repairs	\$435 82	
Furniture	387 30	
Supplies	3,115 27	
Stationery and printing	3,494 19	
Fuel and light	822 19	
Rental	2,875 00	
Janitor	627 90	
Messengers	598 67	
Stenographers	3,336 29	
Instruments	937 63	
Supplies	7,619 05	
H. A. Carson	8,000 00	
Skilled service	97,090 55	
Total		129,339 86

MISCELLANEOUS.

Legal and expert advice	\$8,262 35	
Advertising	861 43	
Labor	11,350 41	
Counting travel	228 26	
Pipe sewer, Common	698 26	
Total		21,400 71

SECTION ONE.

(Public Garden to old Public Library, 2-track; Tremont street from north of Mason to West street, 4-track; completed.)

Jones & Meehan	\$7,321 92	
Department of Public Grounds	311 92	
Legal and expert advice	50 00	
Construction	6,060 04	
Teaming	1,410 15	
Office supplies	10	
Field supplies	7,540 55	
Advertising	3 33	
Labor	11,349 10	
Total		34,047 11

Carried forward,

\$214,493 04

Brought forward,

\$214,493 04

SECTION TWO.

(Old Public Library to north of Mason street ; 2 and 4 track, and station ; completed.)

E. W. Everson	\$86,845 13	
Pennsylvania Steel Co.	12,334 06	
Hallstead & McNaugher	8 19	
Wheelwright & Haven	2,299 07	
Norcross Bros.	27,560 00	
Construction	25,933 44	
Legal and expert advice	289 86	
Office supplies	29 54	
Field supplies	11,635 29	
Advertising	46 67	
Stationery and printing	24 30	
Labor	17,549 35	
Total		184,554 90

SECTION THREE.

(West street to Park street, 4-track and station ; completed.)

F. E. Shaw	\$73,068 06	
Pennsylvania Steel Co.	6,208 96	
Hallstead & McNaugher	8 18	
Wheelwright & Haven	2,299 06	
Norcross Bros.	27,560 00	
Construction	17,569 11	
Office supplies	46 73	
Field supplies	6,512 08	
Advertising	46 67	
Stationery and printing	24 30	
Labor	19,125 30	
Teaming	2,877 90	
Rental	376 66	
Relocating pipes	27 84	
Legal and expert advice	737 36	
Electric conduits	43 63	
Total		156,531 84

SECTION THREE AND ONE-HALF.

(About 25 feet each of two single-track subways from Section 3 to Section 6 ; completed.)

Construction	\$16 48	
Field supplies	66 66	
Labor	58 23	
Total		141 37

SECTION FOUR.

(Tremont street, Section 2, to Hollis street, 2-track ; Hollis to Warrenton street, 4-track ; completed.)

New Jersey Steel & Iron Co.	\$1,077 60	
Metropolitan Construction Co.	189,839 61	

Carried forward,

\$190,917 21 \$555,721 15

<i>Brought forward,</i>	\$190,917 21	\$555,721 15
Construction	16,303 93	
Legal and expert advice	6,375 70	
Rental	350 00	
Fuel and light	47 34	
Office supplies	56 28	
Field supplies	4,458 24	
Labor	8,516 25	
Teaming	753 11	
Relocating pipes	427 46	
Eliot-street sewer	91 99	
Underpinning	785 99	
Electric conduits	1,132 00	
Total		230,215 50

SECTION FIVE.

(Warrenton street to Pleasant street, 4-track and incline ;
completed.)

W. H. Keyes & Co.	\$20,934 15	
Boston Bridge Works	4,058 23	
G. W. G. Ferris & Co.	39 49	
Construction	674 86	
Advertising	174 20	
Legal and expert advice	980 00	
Office supplies	59	
Field supplies	552 94	
Stationery and printing	78 38	
Teaming	501 15	
Labor	1,710 99	
Land damages	213,356 66	
Fuel and light	14 43	
Total		243,076 07

SECTION SIX.

(Tremont street, Section 3½, to near Scollay square, 2-track ;
completed.)

R. A. Malone & Co.	\$27,519 73	
Berlin Iron Bridge Company	5,812 47	
G. W. G. Ferris & Co.	66 51	
Construction	98,241 61	
Office supplies	261 44	
Field supplies	35,930 78	
Teaming	16,378 72	
Labor	102,680 12	
Electric conduits	66 56	
Total		286,957 94

SECTION SEVEN.

(Scollay-square station ; under contract.)

Schailer & Schniglaue Co.	\$35,001 28	
Carnegie Steel Company (Ltd.)	11,853 41	
<i>Carried forward,</i>	\$46,854 69	\$1,315,970 66

<i>Brought forward,</i>	\$46,854 69	\$1,315,970 66
Construction	12,648 13	
Advertising	110 52	
Office supplies	74 72	
Field supplies	4,805 55	
Stationery and printing	154 75	
Teaming	3,931 80	
Labor	20,286 93	
Relocating pipes	966 87	
Rental	41 67	
Electric conduits	27 48	
Total		89,903 11

SECTION EIGHT.

(Hanover street, Section 7 to Section 9, 2-track; completed.)

Metropolitan Construction Company	\$68,465 77	
A. & P. Roberts Co.	12,852 01	
G. W. G. Ferris & Co.	153 25	
Construction	8,436 84	
Advertising	131 70	
Office supplies	12 74	
Field supplies	745 59	
Stationery and printing	93 26	
Teaming	827 67	
Labor	3,615 66	
Relocating pipes	1,656 02	
Rental	75 00	
Fuel and light	33 30	
Electric conduits	38 44	
Total		92,137 25

SECTION EIGHT AND ONE-HALF.

(Cornhill, Section 7 to Section 9, 2-track; under contract.)

National Contracting Company	\$34,351 87	
A. & P. Roberts Co.	12,254 17	
Hallstead & McNaugher	146 63	
Construction	2,168 30	
Advertising	137 34	
Office supplies	10 82	
Field supplies	553 40	
Stationery and printing	127 00	
Teaming	245 60	
Labor	795 00	
Relocating pipes	130 10	
Rental	41 67	
Total		50,961 90

SECTION NINE.

(Adams square, Washington street to Hanover street, 3-track and station; under contract.)

Richardson & Young	\$43,967 56	
Harrington, Robinson & Co.	5,306 38	
<i>Carried forward,</i>	\$49,273 94	\$1,548,972 92

THIRD ANNUAL REPORT.

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<i>Brought forward,</i>	\$49,273 94	\$1,548,972 92
A. & P. Roberts Co.	24,604 63	
G. W. G. Ferris & Co.	54 29	
Hallstead & McNaugher	300 13	
Construction	29,886 10	
Advertising	185 15	
Office supplies	168 56	
Field supplies	12,898 40	
Stationery and printing	132 75	
Teaming	11,069 40	
Labor	49,801 05	
Relocating pipes	2,548 83	
Electric conduits	213 11	
Rental	116 67	
Fuel and light	32 02	
Total		181,285 03

SECTION TEN.

(Washington street, Hanover street to Haymarket square,
4-track, and station at Haymarket square; completed.)

Schailer & Schniglaue Co.	\$72,314 95	
Carnegie Company (Ltd.)	22,550 75	
Pennsylvania Steel Company	9,639 26	
G. W. G. Ferris & Co.	399 78	
Construction	37,834 98	
Advertising	136 20	
Office supplies	170 67	
Field supplies	16,711 40	
Stationery and printing	39 50	
Teaming	8,374 72	
Labor	44,460 06	
Relocating pipes	3,181 10	
Fuel and light	6 42	
Electric conduits	373 55	
Total		216,193 34

SECTION ELEVEN.

(Haymarket square to Travers street, 4-track and incline.)

Construction	\$77 78	
Advertising	30 90	
Legal and expert advice	125 00	
Office supplies	42 47	
Field supplies	952 86	
Teaming	900 96	
Labor	3,087 13	
Relocating pipes	58 92	
Total		5,276 02

INTEREST.

Paid by City Treasurer	86,305 31
<i>Carried forward,</i>	\$2,038,032 62

Brought forward,

\$2,038,032 62

CHARLESTOWN BRIDGE.

General Expenses: 1-5 to Bridge . . .	\$7,426 34
Perkins & White (8 piers) . . .	148,875 40
" " (Fender Contract) . . .	1,948 72
Land damages . . .	125,565 49
Stationery and printing . . .	380 47
Instruments . . .	46 46
Construction . . .	409 37
Office supplies . . .	155 91
Field supplies . . .	202 08
Advertising . . .	157 75
Labor . . .	23 16
Legal and expert advice . . .	2,590 00
Teaming . . .	5 00
William Jackson . . .	2,000 00
Skilled service . . .	11,722 37

Total	301,508 52
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\$2,339,541 14

SUMMARY.

	From beginning of work to Aug. 15, 1896.	Aug. 15, 1896, to Aug. 15, 1897 .	Total.
Subway. — Subway com- mission . . .	\$14,131 16		\$14,131 16
4-5 General Expenses . . .	55,133 05	\$29,705 36	84,838 41
* Engineering Expenses . . .	114,921 16	129,339 86	244,261 02
Miscellaneous . . .	32,924 93	21,400 71	54,325 64
* Section One . . .	197,279 03	34,047 11	231,326 14
Two . . .	145,004 11	184,554 90	329,559 01
Three . . .	97,181 06	156,531 84	253,712 90
Three and one- half . . .	9,311 12	141 37	9,452 49
Four . . .	184,919 60	230,215 50	415,135 10
Five . . .	1,458 59	243,076 07	244,534 66
Six . . .	21,088 08	286,957 94	308,046 02
Seven . . .	80 03	89,903 11	89,983 14
Eight . . .	2,673 88	92,137 25	94,811 13
Eight and one- half . . .		50,961 90	50,961 90
Nine . . .	554 66	181,285 03	181,839 69
Ten . . .	3,045 61	216,193 34	219,238 95
Eleven . . .	752,615 00	5,276 02	757,891 02
East Boston Tunnel . . .	1,129 44		1,129 44
Interest . . .	47,029 38	86,305 31	133,334 69
Total . . .	<u>\$1,680,478 89</u>	<u>\$2,038,032 62</u>	<u>\$3,718,512 51</u>
Bridge. — 1-5 General Ex- penses . . .	\$13,783 26	\$7,426 34	\$21,209 60
Engineering Expenses . . .	9,509 18	294,082 18	303,591 36
Total . . .	<u>\$23,292 44</u>	<u>\$301,508 52</u>	<u>\$324,800 96</u>
Grand Total . . .	<u>\$1,703,772 33</u>	<u>\$2,339,541 14</u>	<u>\$4,043,313 47</u>

* \$48.55 transferred from Section 1 to Engineering Expenses since last report.



THE HELIOTYPE PRINTING CO., BOSTON

N. L. STEBBINS, PHOTOGR.

SECTION 1. -- INCLINE IN PUBLIC GARDEN, LOOKING EASTERLY.

The reports of the Chief Engineer and of the Chief Engineer for Charlestown Bridge are appended.

GEORGE G. CROCKER,	}	<i>Boston Transit Commission.</i>
CHARLES H. DALTON,		
THOMAS J. GARGAN,		
GEORGE F. SWAIN,		
HORACE G. ALLEN,		

Report of
Chief
Engineer.

REPORT OF THE CHIEF ENGINEER.

BOSTON, August 16, 1897.

GEORGE G. CROCKER, CHARLES H. DALTON, THOMAS J. GARGAN, GEORGE F. SWAIN, HORACE G. ALLEN,
Boston Transit Commissioners:

GENTLEMEN: I submit herewith a report of the work done on the subway during the past year:

PROGRESS.

The portions of the subway that have been completed and those that are now (August 15, 1897) under construction, together with other information, can be seen on the progress map which precedes this report.

The following table indicates briefly the present situation:

Section 1, Boston Common, is completed.

“ 2, Boston Common, is completed.

“ 3, Boston Common, is completed.

“ 3½, foot of Park street, is completed.

“ 4, Tremont street, south of Boylston street, is completed except ventilating chamber.

“ 5, at Tremont street and Shawmut avenue, is not entirely completed on account of anticipated changes in connection with the proposed elevated road. It is sufficiently completed, however, to be used by the West End Street Railway Company.

“ 6, Tremont street, between Park street and Scollay square, is completed except as to the interior finish.

“ 7, Scollay square. About 64 per cent. is completed. It will probably be finished except as to interior finish before Christmas, unless one or more additional platforms are built.

“ 8, Hanover street, is completed except as to the interior finish.

“ 8½, Cornhill, is completed except as to a part of the ventilating chamber, and as to the interior finish.

“ 9, Adams square to Hanover street. About 65 per cent. is completed. It will probably be finished except as to interior finish before Christmas.

“ 10, Washington street, from Hanover street to old Boston and Maine Station, is completed except as to interior finish.

“ 11, near Haverhill street, north of Haymarket square. The steel work is contracted for, but the original plans may be changed on account of the proposed elevated road.

Of the subway as a whole about 87 per cent. has been completed, and about 7 per cent. more is under contract or ordered to be done directly by the Engineering Department. If it were not for the uncertainty in regard to the portion north of Haymarket square, the whole subway might be ready for use early next spring.



N. L. STEBBINS, PHOTOGR.

THE HELIOTYPE PRINTING CO., BOSTON

SECTION 1. --- INCLINE IN PUBLIC GARDEN, LOOKING WESTERLY.

OPENING OF SECTIONS 1, 2, 3, 4, AND 5 FOR PUBLIC TRAVEL.

Report of
Chief
Engineer.

It is expected that the first three of these sections will be placed in service on the first day of September, and Sections 4 and 5 three or four weeks later. A large number of alternative plans were made for the different parts of these sections. It appeared probable from the first that the subway would be leased by the West End Street Railway Company, and therefore the plans were discussed with the executive officers of that company as the work progressed. The questions considered covered, among other things, the position and arrangement of stations, grades, width and shape of platforms, width of stairways, general plan of construction, general dimensions, sub-subways for the avoidance of grade crossings, cross-overs, curves, and various other matters. These discussions began October 25, 1894, about five months before the first excavation was begun in the Public Garden. The officers of the company suggested some changes, and such of these as were finally recommended by them prior to letting the contracts were adopted, and the plans as adopted were approved by them. It was decided, among other things, that the two easterly tracks of the four-track subway should be for north-bound cars, and should have island platforms between them; that the two westerly tracks should be for south-bound cars, and should also have island platforms between them; that the platforms should be as wide and as long as the law, and due regard for the preservation of trees on the Common, permitted; that the stairways on the Common should be 15 feet wide; that the distance between the top of the track and the roof of the subway should be 14 feet, and that the platforms should be placed as near the surface of the ground as practicable, in order that the stairways should be as short as possible. It was provided in the contract drawings that the passenger platforms of the stations should be at the level of the track. This would enable every portion of the edge of the platform, whether straight or curved, to be used by the cars in receiving and discharging passengers. At a later time, after a conference with railway officials, it was decided to make the platforms about a foot higher than the rails, although this would result in throwing out of use a portion of the edge of the platform where the curvature was considerable. The requirements of wide platforms and wide stairways, combined with the legal and other limitations, involved much curvature of tracks; and to avoid injury to private property near Hotel Pelham, and near Park-street church, in passing from the Common to the street, it was necessary to add still further to the curvature. The position

Report of
Chief
Engineer.

of the platform near the surface of the ground, taken in connection with the sub-subway for the avoidance of grade crossings, required steep grades. The ascents and curves are not more pronounced than those shown on the plans at the legislative hearings preceding the passage of the law creating the Boston Transit Commission, and are exceeded in numberless cases on electric surface railways in almost all parts of the country.

In the foregoing sections the West End Street Railway Company has already laid the track and put in electric lighting and power and other equipment. This work has been done in a most substantial and satisfactory manner, and will help to insure the successful and safe operation of the subway.

INTERIOR FINISH OF THE WALLS OF THE SUBWAY.

It was decided that the sides of the subway near the stations should be lined with white enamelled brick, and that the side-walls elsewhere and the roof everywhere should be treated with some less expensive coating of a light color. Many experiments were made in the Boylston-street subway, and the preparations of various manufacturers and dealers were tried. These experiments were necessary because it was well known that the efflorescence which always appears for a year or more on the surface of cement concrete was very liable to attack and injure any surface application. One of the coatings, after remaining on the walls several months subject to daily washing, was found in apparently perfect condition, and it was concluded to extend the experiment by applying it to the remaining portions of Sections 1, 2, and 3. The interior finish applied to these sections has to most observers a pleasant appearance, but has not proved nearly so satisfactory as the sample first tried. It can, however, be replaced whenever desirable or necessary. The coating applied in Section 4 appears likely to be satisfactory in every way, and unless something better is found it will probably be applied to the other seven sections of the subway, except near stations, where enamelled brick will be used.

PLANS. — UNDERGROUND SURVEYS.

Eleven hundred and twenty plans have been made during the year. Thirty-three additional borings for sub-surface surveys have been made during the same period.

OFFICE ASSISTANTS, AUGUST 15, 1897.

Some of the assistants in the Engineering Department are named below, and an indication of their work is given.



THE HELOTYPE PRINTING CO., BOSTON

BOSTON TRANSIT COMMISSION

SECTION 1.--BOSTON COMMON. TWO-TRACK SUBWAY UNDER BOYLSTON-STREET MALL, LOOKING
EASTERLY.

*Assistant Engineers.*Report of
Chief
Engineer.

EDMUND S. DAVIS, General oversight of field, and miscellaneous office work.

JOSEPH R. WORCESTER, Designs for steel work.

GEORGE H. STEARNS, " " " "

CHAUNCEY R. PERRY, " " " "

CHARLES H. SWAN, Studies for changes in sewers, pipes, etc.

HORACE J. HOWE, Preliminary surveys and studies for stations.

WILLIAM W. LEWIS, Studies for locations and designs for subways.

A. N. WAHLBERG, " " " " " " " "

Draughtsmen, Transitmen, etc.

JOHN WORCESTER, Draughtsman.

WILLIAM F. MANN, "

A. F. BILDT, "

RUSSELL L. ELLIOT, "

CHARLES A. WENTWORTH, "

SHERMAN A. JUBB, "

J. ALBERT COLE, "

HENRY R. KIMBALL, "

WILLIAM J. J. YOUNG, "

CHARLES W. FURLONG, "

LEONARD B. HOWE, "

WILLIAM J. WATKINS, "

NELSON A. HALLETT, Cement Tester.

ARTHUR B. CARTER, Clerk and Stenographer. Correspondence, collected and compiled data.

EMMA BATCHELDER, Stenographer.

JAMES P. LYNCH, Stenographer.

WALTER F. CLARE, Purchasing Clerk.

CHARLES F. CAHILL, Assistant Purchasing Clerk.

FRED W. STILES, Draughtsman and Plan-keeper.

W. H. KENYON, Blue-printer.

GEORGE P. GOODMAN, Photographer.

F. L. TIBBETTS, Rodman assisting in matters pertaining to the Civil Service in regard to laborers.

FIELD ASSISTANTS, AUGUST 15, 1897.

GUY C. EMERSON, Assistant Engineer. General inspection.

A. W. PARKER, General steel inspection.

E. A. CLARK, Foreman.

The remainder and much the larger portion of the force of field assistants are mentioned in the accounts of the sections.

CONSTRUCTION.

Detailed statements of the work on the sections done by contract or by day-work are given in the following pages. They are in part based upon the reports of Assistant Engineers Edwards, Shepherd, O'Brien, Marden, Palmer, and L. H. Davis.

Report of
Chief
Engineer.

The progress of the work towards completion is such that in a short time the further services here of a considerable number of these men will no longer be necessary. I desire to here express, both to those who are soon to go and to those who are to remain for a longer time, my high appreciation of their valuable services.

Section 2.

WORK DONE ON **Section 2** OF THE SUBWAY FOR THE YEAR ENDING AUGUST 15, 1897. (CONTRACT WORK.)

Location. — Boston Common, corner of Tremont and Boylston streets.
Contractors for Steel Work. — THE PENNSYLVANIA STEEL COMPANY, Steelton, Pa.

Contractor for Construction. — EDWARD W. EVERSON, Providence, R.I. J. J. EVERSON, brother to the contractor, Superintendent.

City Assistants. — Frank C. Shepherd, Assistant Engineer; Carl S. Drake, Transitman; William O. Wellington, Assistant Transitman; George M. Stevens, Rodman; George M. Hawes, Assistant (estimates, etc.); George H. Foss, Jr., Inspector; William Park, Inspector of Masonry; Charles F. Hall, Inspector of Steel Erection.

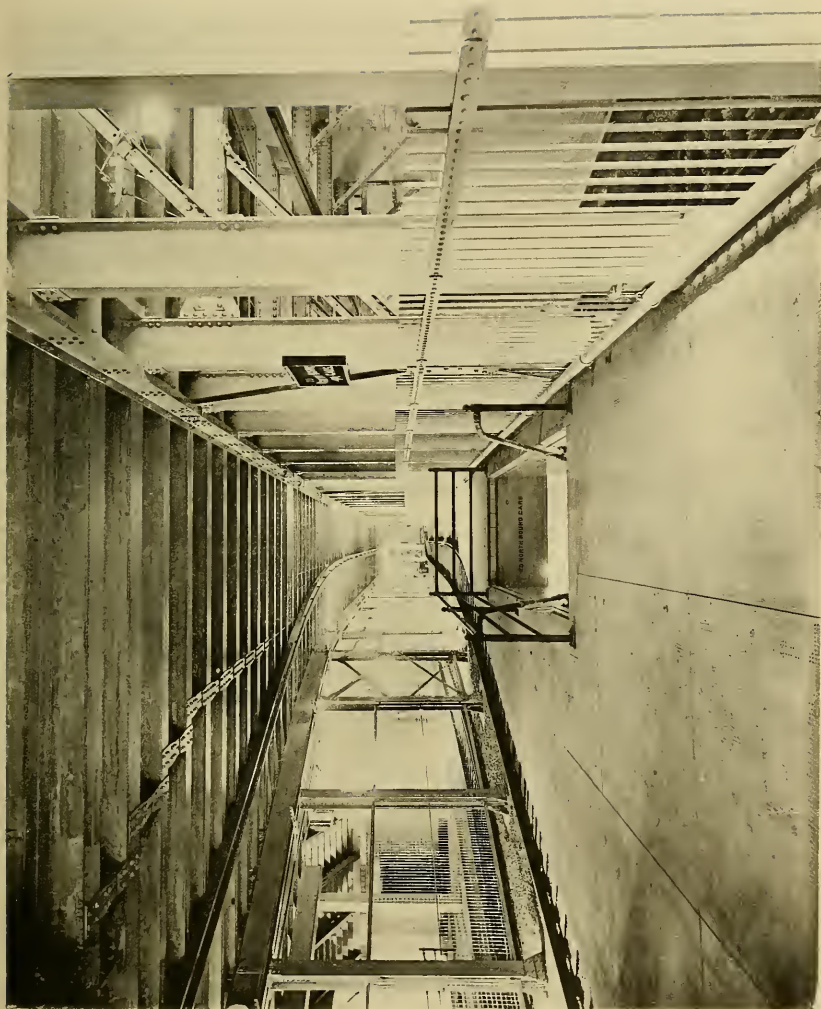
	Bids opened.	Date of contract.	Final certificate given.
Steel work . . .	Sept. 12, 1895.	Sept. 13, 1895.	June 11, 1896.
Construction . .	Sept. 19, 1895.	Sept. 20, 1895.	Nov. 28, 1896.

Work referred to in previous Annual Report. — As stated in the last annual report, excavation was begun in a small way October 22, 1895, and regular operations commenced November 29, after the erection of the special machinery designed by the contractor. At the close of the year (August 15, 1896) only about 70 per cent. had been excavated, although the whole section should have been completed, according to contract, on May 30th. The quantities remaining to be done August 15, 1896, are shown in table on page 27.

Structures and Methods of doing Work. — Details of the structure and of the special machinery used by the contractor were given in last year's report. The general shape, dimensions, and position of the section are shown on the progress map at the beginning of this report. In August, 1896, the use of the special machinery, so far as relates to the mixing of concrete, was discontinued. The sand and gravel were thenceforward screened by manual labor in the trench, and the concrete-mixing was also done by hand. Comparatively rapid progress was made thereafter, and the section was completed November 28, 1896.

During the past year two pipe-passages were completed in the roof of the subway opposite Mason street, and in one of these a 16-inch water-pipe was laid.

The front face of the station platforms consists of a concrete wall 2 feet thick carried up to within 6 inches of plat-



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N. L. STEBBINS, PHOTOGR.

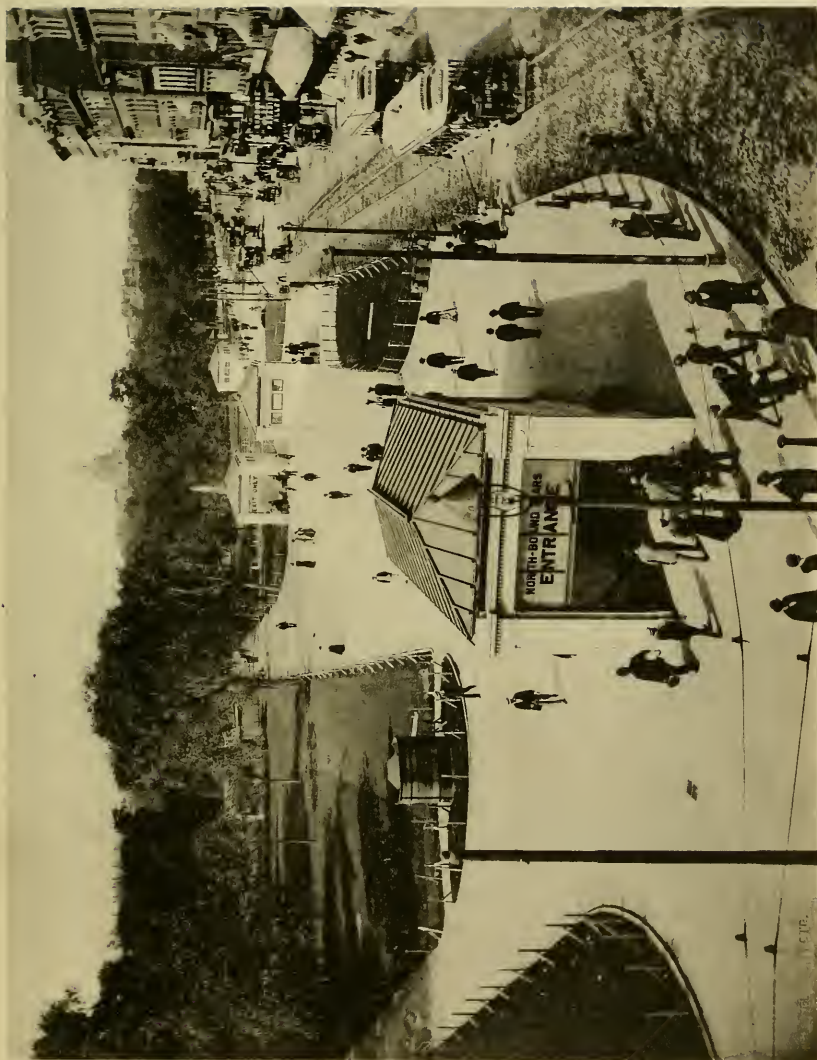
SECTION 2.--BOYLSTON-STREET STATION, ENTRANCE TO SUB-PASSAGE BETWEEN PLATFORMS,
LOOKING SOUTHERLY.



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N. L. STEBBINS, PHOTOGR.

BOYLSTON-STREET STATION, LOOKING SOUTHERLY, INCLINE TO SUB-SUBWAY.



THE HELIOTYPE PRINTING CO., BOSTON

N. L. STEBBINS, PHOTOGR.

STAIRWAY COVERINGS TO BOYLSTON-STREET STATION, LOOKING NORTHERLY.



THE HELIOTYPE PRINTING CO., BOSTON

BOSTON TRANSIT COMMISSION

SECTION 1.-- BOSTON COMMON. FOUR-TRACK SUBWAY UNDER TREMONT-STREET MALL, LOOKING
NORTHERLY FROM SECTION 2. JULY 30, 1897.



THE HELIOTYPE PRINTING CO., BOSTON

BOSTON TRANSIT COMMISSION

SECTION 1.-- BOSTON COMMON. FOUR-TRACK SUBWAY UNDER TREMONT-STREET MALL, LOOKING SOUTHERLY. JULY 27, 1897.

form grade. Sand and gravel filling was deposited behind these walls. This material was hauled from the dump on the Common and put in place by Charles Linehan, under a separate agreement. Report of
Chief
Engineer.
Section 2.

Force employed. — The force ordinarily employed by the contractor consisted of 150 men and 3 teams working 10 hours per day. The following table shows the rate of progress from August 15, 1896, to the completion of the work, also the total amount of work in the whole section :

ITEMS.	Amount of work done previous to Aug. 15, 1896.	Date of completing.	Amount of work during year ending Aug. 15, 1897.	Average rate of progress per week during respective working periods, year ending Aug. 15, 1897.	Total quantities in completed section.
	<i>Cubic yards.</i>	<i>1896.</i>	<i>Cubic yards.</i>	<i>Cubic yards.</i>	<i>Cubic yards.</i>
Excavation . .	39,259	Oct. 23	18,552	1,883	57,811
Concrete invert,	1,869	Oct. 28	1,417	134	3,286
Footings-stones .	123	Oct. 29	103	9	226
Steel erection .	770 tons	Nov. 7	738 tons	61 tons	1,508 tons
Concrete walls .	929	Nov. 11	829	66	1,758
Brick masonry .	467	Nov. 13	656	50	1,123
Concrete in roof,	928	Nov. 14	1,360	105	2,288
Plastering . . .	2,030 sq. yds.	Nov. 19	5,649	412 sq. yds.	7,679 sq. yds.
Waterproofing .	5,097 sq. yds.	Nov. 20	7,178	518 sq. yds.	12,274 sq. yds.

Character of Excavation. — The upper four feet of excavation consisted of surfacing and loam. Below this was gravel and sand of various degrees of fineness to grade. After leaving the deep excavation for the sub-subway at Boylston street, no ground water was met with in the trenches.

Accident. — On Labor Day, September 7, 1896, Gaetano Harloni, an Italian laborer, was crushed between a swinging bucket and a 16-inch water-pipe which ran across the trench, and was instantly killed.

WORK DONE ON **Section 3** OF THE SUBWAY FOR THE YEAR ENDING AUGUST 15, 1897. (CONTRACT WORK.) Section 3.

Location. — From the southerly side of West street under the Common and partly under Tremont and Park streets to the northerly side of the latter street.

Contractors for Steel Work. — THE PENNSYLVANIA STEEL COMPANY, Steelton, Pa.

Contractor for Construction. — FREDERICK E. SHAW, Providence, R.I.
JAMES E. FURBER, Superintendent.

City Assistants. — P. F. O'Brien, Assistant Engineer; F. O. Holmes, Transitman; G. P. Cowan, Assistant Transitman; William H. Boardman, Jr., Assistant; T. W. Bailey, Rodman; Samuel Corning, Inspector; * John W. Linzee, Jr., Inspector.

* Part of the time only.

Report of		Bids opened.	Date of contract.	Final certificate given.
Chief Engineer.	Steel work . . .	Oct. 24, 1895.	Oct. 25, 1895.	June 22, 1896.
Section 3.	Construction . . .	Oct. 17, 1895.	Oct. 21, 1895.	March 10, 1897.

Work referred to in previous Annual Report. — About 70 per cent. of the excavation, mostly in the portion under the Common, was completed at the above-mentioned date. The part under Park and Tremont streets, of a more difficult character, was only just begun. About 54 per cent. of the invert was in place, with about the same proportion of footing stones set. Of the steel work (begun June 12, 1896) about 37 per cent. was in place, and about 15 per cent. of the side-walls had been completed. The roof and waterproofing work were proportionately well advanced. No backfilling had been done.

General Description of Structures. — The leading features of this section were set forth in last year's report. Its general shape, dimensions, and position are shown on the progress map at the beginning of this report. Briefly, the section consists of a four-track subway extending from West street to Park street, divided so as to form a station (to be called Park-street station), with two island platforms and two loop tracks for return cars, and including provision for through traffic by means of a two-track continuation to Scollay square. The floor and foundations of subway and station are of concrete. The side-walls and roof are combinations of steel beams and brick and concrete masonry, with the usual waterproofing of cement plaster and asphalt. The concrete platform walls were included in the contract work.

Method of doing Work. — All excavation was in open cut, the bulk of the excavated material being hauled away by teams up an inclined roadway. After the steel work was begun, the derricks used for placing the steel were also used to hoist the earth into carts on the bank. In the work on Park street the excavation was so arranged as to leave one-half of that street available for traffic. During the progress of excavation on Tremont street the street cars travelled over temporary tracks laid upon the completed portion of the subway roof from Park street to Temple place, as shown by the photographic view, Plate 18. This plan had the advantage of leaving room for the movement of ordinary vehicles on the easterly side of Tremont street, where the traffic is extremely congested. No night work was done except during October and November, 1896, when two 10-hour shifts were worked in order to expedite progress on the excavation in Tremont and Park streets. The average force employed was about 100 men, working one shift of 10 hours, with 10



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N. L. STEBBINS, PHOTOGR.

PARK-STREET STATION, LOOKING NORTHERLY.



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N. L. STEBBINS, PHOTOGR.

PARK-STREET STATION, NORTH-BOUND PLATFORM, LOOKING SOUTHERLY.



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SMITH & MILLER, PHOTOGRS.

SECTION 3.-- BOSTON COMMON. RETURN LOOPS AND CAR-PIT IN PARK-STREET STATION,
LOOKING SOUTHERLY.



THE HELIOTYPE PRINTING CO., BOSTON

BOSTON TRANSIT COMMISSION

SECTION 3.--BOSTON COMMON. RETURN LOOPS IN PARK-STREET STATION, LOOKING NORTHERLY FROM THE SOUTH-BOUND PLATFORM.



THE HELIOTYPE PRINTING CO., BOSTON

BOSTON TRANSIT COMMISSION

SECTION 3.-- BOSTON COMMON, TREMONT-STREET WALL. PIPE CROSSING IN ROOF OF SUBWAY
OPPOSITE WEST STREET. FEBRUARY 15, 1897.



THE HELIOTYPE PRINTING CO., BOSTON

BOSTON TRANSIT COMMISSION

SECTION 3.--BOSTON COMMON. CARS RUNNING ON TEMPORARY TRACK
OVER ROOF OF SUBWAY. NOVEMBER 27, 1896.



THE HELIOTYPE PRINTING CO., BOSTON

N. L. STEBBINS, PHOTOGR.

STAIRWAY COVERINGS TO PARK-STREET STATION, LOOKING SOUTHERLY.



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BOSTON TRANSIT COMMISSION

STAIRWAY COVERING OVER ENTRANCE FOR SOUTH-BOUND CARS, PARK-STREET STATION,
LOOKING SOUTHERLY.

double teams. The rate of progress is shown by the following table :

Report of
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Engineer.

Section 3.

Progress.

ITEMS.	Amount of work done previous to Aug. 15, 1896.	Date of completing.	Amount of work done during year ending Aug. 15, 1897.	Average rate of progress per week during respective working periods, year ending Aug. 15, 1897.	Total quantities in completed section.
	<i>Cubic yards.</i>		<i>Cubic yards.</i>	<i>Cubic yards.</i>	<i>Cubic yards.</i>
Excavation . . .	35,606	Dec. 11 1896	15,804	930	51,410
Concrete invert . .	1,730	Jan. 23, 1897	1,449	63	3,179
Granite footing-stones	116	Dec. 9, 1896	99	6	215
Steel erection . . .	510 tons	Jan. 2, 1897	842 tons	42 tons	1,352 tons
Concrete walls . . .	200	Jan. 9, 1897	1,025	49	1,225
Brick masonry . . .	151	Jan. 11, 1897	871	40	1,022
Concrete in roof . .	264	Jan. 23, 1897	1,938	84	2,202
Plastering	1,010 sq. yds.	Mar. 2, 1897	8,790 sq. yds.	309 sq. yds.	9,800 sq. yds.
Waterproofing . . .	1,010 sq. yds.	Mar. 6, 1897	8,790 sq. yds.	313 sq. yds.	9,800 sq. yds.
Underdrain	1,000 l. ft.	Jan. 12, 1897	2,050 l. ft.	96 l. ft.	3,050 l. ft.

The contract work was substantially completed March 10, 1897.

Character of Excavation. — The fine clayey gravel referred to in last year's report was found throughout the remainder of the work. It was such as to allow nearly vertical banks to stand for a long time without sheeting, but great care was necessarily exercised in bracing and other precautions in the vicinity of Park-street church. The volume of ground water encountered was very small, and was ordinarily handled by means of a hand pump, but the 4-inch pulsometer which had been installed just before the commencement of the year under review was maintained in operation as a matter of convenience in working.

Accident. — One fatal accident occurred during the year, in connection with the work, but not actually upon it. On November 1, 1896, workmen of the Boston Gas Light Company were engaged in relaying the four lengths of 24-inch gas-main which had been washed out by a heavy rain-storm in July, as referred to in last year's report. Patrick McLaughlin, a laborer, was driving yarn into a joint of the pipe when a sheet of paving foundation, of concrete, fell on him, crushing his head against the pipe.

Report of
Chief
Engineer.

WORK DONE ON Section 4 OF THE SUBWAY FOR THE YEAR ENDING AUGUST 15, 1897. (CONTRACT WORK.)

Section 4.

Location. — On Tremont street, from near the northerly line of Boylston street to near the centre of Warrenton street.

Contractor for Steel Work. — NEW JERSEY STEEL & IRON COMPANY, Trenton, N.J.

Contractor for Construction. — METROPOLITAN CONSTRUCTION COMPANY, Boston. GEORGE W. JUDD acted as superintendent.

City Assistants. — F. B. Edwards, Assistant Engineer; G. M. Bacon, Principal Transitman; F. H. Morris, Assistant Transitman; A. W. Trefry, Assistant (street occupancy and force accounts); W. E. Watkins and E. S. O'Neil, Rodmen; W. A. Rogers, W. M. Bailey, J. W. Martin, and * James E. Coyne, Inspectors; John E. Newlands, Assistant on Steel Work.

	Bids opened.	Date of contract.	Final certificate given.
Steel work .	March 12, 1896.	March 17, 1896.	June 22, 1896.
Construction .	March 19, 1896.	March 21, 1896.	

Work referred to in previous Annual Report. — The "slice" method of construction, described in the Second Annual Report, was specified in the contract for this section of the subway. Each "slice" is a portion of the structure, measuring 12 feet, more or less, along the line of the work, and in some places occupying the whole width of the street. The "slices" were built separately. In the masonry structure a solid section of street 12 feet or more in length is left on each end undisturbed until the practical completion of the masonry and the backfilling over it.

This system admits of a very simple method of bridging the street and supporting the numerous gas-pipes, water-pipes, sewers, and other underground structures. It also lessens the liability of causing the settlement of buildings.

On August 15, 1896, out of the 89 "slices" of which this section is composed, excavation had been opened in 61, having an aggregate length of 732 feet. The masonry had been practically completed in 235 lin. feet of the double-barrel subway between Boylston street and Van Rensselaer place, and in 30 lin. feet of the double-barrel subway south of Seaver place. In addition to these, 357 lin. feet of the wide single-arch subway was completed, excepting only the roof of one "slice." One "slice" of steel work near Warrenton street was completed.

General Description of Structures. — As more fully described in the Second Annual Report, this section consists in part of two separate single-track subways under Boylston street connecting with the Boylston-street station, of which

* Part of time only.

the westerly one has the bottom of its masonry about 39 feet below the surface, where it leaves the Boylston-street station. Report of
Chief
Engineer.

This depth, 13.5 feet below the level of the easterly section at the same point, is necessary to allow the Tremont-street south-bound cars to pass under the Boylston-street subway in the station. The two single tracks converge opposite the Hotel Pelham and form a "double-barrel" subway, which is continued in Tremont street to a point about 30 feet south of Van Rensselaer place, near which point the difference in level between the easterly and westerly tracks ceases. From the point near Van Rensselaer place to near the north-erly side of Seaver place the subway is a single "wide arch" two-track structure. At the southerly side of Seaver place the double-barrel type again occurs and a renewed divergence of grade commences, for the purpose of allowing the Shawmut-avenue south-bound track to pass under the Tremont-street north-bound track near Common street. Section 4.

It was necessary to remove the sewer in Tremont street between Boylston street and Warrenton street. To take the place of this sewer two vitrified pipe sewers were laid, one on each side of the subway. These sewers were mostly laid in the same trench as the subway. To prevent settlement the pipe when in subway trench was laid on steel channel beams and surrounded with concrete. The channel beams were from 8 to 16 feet in length, laid horizontally with the flanges projecting upward. The ends rested upon masonry piers with intermediate supports of timber posts. The trench outside of the finished subway was filled with concrete under man-holes. The total work upon sewer on this section is as follows:

2 ft. of 20-in. vitrified pipe.	19 manholes.
854 " " 12-in. " "	2 lamp-holes.
1,045 " " 10-in. " "	1 catch-basin rebuilt.
25 " " 24-in. brick sewer.	

Method of doing Work. — The work was carried on day and night, substantially without interruption, from March 30, 1896, to March 13, 1897. Ordinarily 100 men and 10 teams were employed during the day and 60 men and 9 teams at night, working 10-hour shifts. The operations were conducted throughout without materially obstructing any class of traffic. On special occasions, by arrangement with the West End Railway Company, the street cars ceased running over a part of the street from 11 P.M. on Saturday to 6 A.M. of the Monday following. The following table shows the rate of progress for each class of work:

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Section 4.

ITEMS.	Amount of work done previous to Aug. 15, 1896.	Date of completing.	Amount of work during year ending Aug. 15, 1897.	Average rate of progress per week during respective working periods, year ending Aug. 15, 1897.	Total quantities in completed section.
	<i>Cubic yards.</i>		<i>Cubic yards.</i>	<i>Cubic yards.</i>	<i>Cubic yards.</i>
Excavation . . .	26,465	Dec. 20, 1896	24,800	1,370	51,265
Concrete invert . .	1,630	Dec. 28, 1896	1,430	74	3,060
Steel erection . .	185 tons	Jan. 11, 1897	369 tons	17 tons	554 tons
Concrete walls . .	1,790	Jan. 17, 1897	3,620	164	5,410
Brick masonry . .	1,126	Feb. 24, 1897	1,442	52	2,568
Concrete in roof .	950	Mar. 3, 1897	1,500	52	2,450
Plastering . . .	4,400 sq. yds.	Mar. 8, 1897	10,834 sq. yds.	370 sq. yds.	15,234 sq. yds.
Waterproofing . .	8,000 sq. yds.	Mar. 11, 1897	11,027 sq. yds.	371 sq. yds.	19,027 sq. yds.
Rib-tiling . . .	675 sq. yds.	Mar. 8, 1897	1,485 sq. yds.	51 sq. yds.	2,160 sq. yds.
Rosendale concrete . . .	420	Dec. 12, 1896	130	8	550
Underdrain . . .	690 ft.	Dec. 7, 1896	185 ft.	11 ft.	875 ft.

Character of Excavation. — The depth of excavation varied from 39 feet in the westerly branch at north side of Boylston street to 21 feet in the easterly branch at Common street. At the first-named point fine sand prevailed throughout, with some water in the bottom. A considerable part of the excavation was in clay, some of it with fine sand at bottom. Ground water was found in most of the slices, but the amount was comparatively small, and most of it was carried through an under-drain to a permanent pump-well at Eliot street. A pulsometer fixed at this well worked intermittently, night and day, during the continuance of the work. One of the permanent electric centrifugal automatic pumps was set up in the pump-chamber and commenced running February 19, 1897, the pulsometer being then discontinued. Another similar pump, provided as a reserve, was placed in position a few days later.

Gas Explosion above the Subway at the Junction of Boylston and Tremont Streets. — By this explosion, which took place March 4, 1897, about fifteen minutes before noon, six persons were killed and four more died a short time subsequently. Others were more or less seriously injured, and considerable damage was done to property. The subway structure was not damaged, and the men working therein directly under the scene of the explosion felt only a slight concussion.

The work on Section 4 at the time of the explosion had been substantially completed for its entire length of about 1,172 feet. The plastering and waterproofing on the high barrel arch of the subway at this point had not, however,

been quite finished, and there was an irregular space, then but partly backfilled, from 32 to 62 feet long, from 23 to 48 feet wide, and from 3 to 11 or 12 feet deep.

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By the act creating the Transit Commission it is required "to so conduct the work of construction that all streets and places under or near which a subway is constructed shall be open for traffic between 8 o'clock in the forenoon and 6 o'clock in the afternoon." This provision was of especial importance here on account of the enormous amount of street traffic. The usual number of cars passing over this bridge daily was about 5,600, and there were, in addition, other vehicles of every description and a large number of pedestrians. With the complicated shape of the subway as it exists in this locality there was no other way of complying with the provisions of the law than by in some manner keeping the surface bridged while the various operations of excavating for and building the subway were going on. This bridging was constructed in a safe and substantial manner.

WORK DONE ON **Section 5** OF THE SUBWAY FOR THE YEAR **Section 5.** ENDING AUGUST 15, 1897.

Location.—In and near the so-called triangle bounded by Warrenton, Tremont, and Pleasant streets and Shawmut avenue.

Contractors for Steel Work.—BOSTON BRIDGE WORKS, 70 Kilby street, Boston.

Contractors for Construction.—W. H. KEYES & Co., 17 Otis street, Boston.

City Assistants.—F. B. Edwards, Assistant Engineer; A. G. Fogg, Transitman and Inspector; A. C. Lootz and C. I. Crocker, Assistant Transitmen.

	Bids opened.	Date of contract.	Final certificate given.
Steel work .	Aug. 13, 1896.	Aug. 20, 1896.	Oct. 25, 1896.
Construction .	Aug. 27, 1896.	Sept. 1, 1896.	Jan. 16, 1897.

Condition of Work August 15, 1896.—As stated in the Second Annual Report, the work of removing the buildings on the triangle, under a separate contract, was completed May 15, 1896. The ground being thus cleared, operations were begun by W. H. Keyes & Co. September 3, 1896. The section was completed January 9, 1897.

General Description of Structures.—This section is about 216 feet long, of irregular shape, and includes a length of four-track subway adjoining and south of the four-track subway at Section 4, and an open incline by which these four tracks reach the surface at Pleasant street. The position of the section with relation to the rest of the subway

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can be seen on the progress map. The structure has been so designed as to admit of erecting a fireproof construction building (say an apartment house) of eleven stories in height over the nearly triangular space included between Shawmut avenue and Tremont street, and between Warrenton and Pleasant streets. On the Tremont-street, Shawmut-avenue, and Warrenton-street sides the foundations for such a structure have been put in as part of the subway work.

Where the tracks pass under the streets they are spanned by heavy plate girders, suitable for carrying the weights of those parts of a building which may come over them.

Force employed. — The number of men ordinarily employed by the contractors was 18 during the day and 15 at night. Work was carried on during 135 days and 75 nights. The date of completion (January 9, 1897) was 7 weeks beyond the date named in contract.

The following table shows the progress of the work :

Progress.

ITEMS.	Date of beginning.	Date of completing.	Total quantities in completed section.	Average rate of progress per week during respective working periods.
	1896.		<i>Cubic yards.</i>	<i>Cubic yards.</i>
Excavation	Sept. 5	Jan. 9, 1897	5,430	302
Concrete invert	Nov. 4	Jan. 4, 1897	302.2	35
Granite footing-stones . . .	Oct. 26	Dec. 5, 1896	40	7
Steel erection	Nov. 23	Dec. 19, 1896	79 tons	20 tons
Concrete walls	Oct. 25	Jan. 4, 1897	808.2	81
Brick masonry	Dec. 13	Dec. 30, 1896	29.9	12
Concrete in roof	Dec. 14	Dec. 31, 1896	81	32
Granite masonry	Nov. 3	Dec. 8, 1896	172	34
Plastering	Nov. 9	Jan. 6, 1897	978 sq. yds.	116 sq. yds.
Waterproofing	Nov. 6	Jan. 10, 1897	1,508 sq. yds.	160 sq. yds.
Rib-tiling	Nov. 12	Jan. 6, 1897	78 sq. yds.	10 sq. yds.

Character of Excavation. — The earth excavation was chiefly in blue clay ; there was no water in the trench except surface water after rains.

Section 6. **WORK DONE ON SECTION 6 OF THE SUBWAY FOR THE YEAR ENDING AUGUST 15, 1897. (DIRECT WORK.)**

Location. — In Tremont street, from Park street to a point about 64 feet south of Court street.

Contractors for Steel Work. — THE BERLIN IRON BRIDGE COMPANY, East Berlin, Conn. Contract dated May 4, 1896.

City Assistants. — Henry H. Marden, Jr., Assistant Engineer in Charge; E. Elbert Young, Assistant Engineer; John J. Falvey, Transitman; George E. Harkness and Howard E. Smith, Assistant

Transitmen; Perley B. Palmer, Rodman and Leveller; George P. Carver, Leonardo Furlong, and E. W. Crocker, Rodmen; Charles H. Johnson and Charles A. Wentworth, Draughtsmen (computing, etc.); C. H. Smith, C. P. Horton, J. Driscoll, W. B. Keith, and W. A. Rowell, Inspectors; B. Rudolph Dorman, Inspector, Acting Day Foreman; Michael Tallent, Night Foreman; James F. Cloney, Timekeeper.

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Work referred to in previous Annual Report. — As stated in the last annual report, the Commission on August 13, 1896, arranged with the Contractors for Construction (R. A. Malone & Co., of Boston) that they should cease all work within a week, and on the same date directed the Chief Engineer to proceed with the work by men employed directly by the Commission. The section is 1,085 feet long. When the contract for its construction was let, it was intended to build the greater part of this length by some acceptable method of tunnelling, the exceptions consisting of 24 feet at the northerly end and 130 feet at the southerly end, which were to be built by the "slice" method. But at the request of the contractors the northerly length of 24 feet was increased to 48 feet at the start, and at a later stage they received permission to finish all work north of Beacon street by that method. As the result of these changes, the condition of the work on its being taken over by the Commission was as follows:

One "slice" at Park street had been excavated to grade.

One "slice" at the centre of the Tremont building had been excavated to grade, and four headings for side-wall tunnels started from it.

From School street to the northerly end of the section "slices" were in process of excavation, masonry construction, or backfilling respectively. Most of the side-wall in this length was built, and a top-heading, for continuation of the contractors' crown-bar method, had been driven for about 90 feet.

General Description of Structures. — The details of the proposed structure were fully described in the last annual report. Its position with relation to the rest of the subway can be seen in the progress map. The greater portion of the section consists of a "wide-arch" two-track subway; at the southerly end, near Park-street church, the two tracks diverge into short lengths of separate single-track subway to connect with the Park-street station. The separation of the tracks is effected in an enlarged "bell-mouth" structure.

The ventilating chamber, referred to and illustrated in last year's report (Plate 38), has been built during the year under review in the position then assigned to it in the burial-

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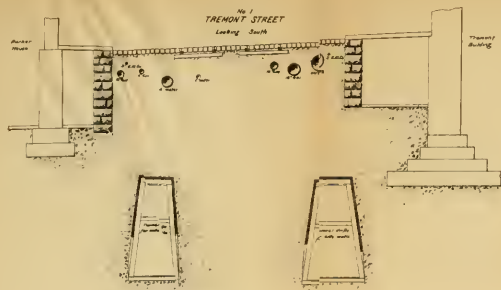
ground just north of King's chapel. It measures 10 feet by 27 feet inside, with an outlet shaft 9 feet diameter inside. The shaft is covered by an octagonal steel hood, enclosed with an iron fence similar in design to the fence separating the burial-ground from the street. The portion appearing in the burial-ground is designed to be inconspicuous.

The subway interfered with a 15-inch pipe-sewer crossing Tremont street from Beacon to School street. This was temporarily siphoned under the incomplete excavation of the subway at about half the height of the side-walls, and subsequently replaced by a 20-inch steel pipe, lined with one inch of Portland cement mortar inside, built into the arches at the proper height. Two new manholes were built in connection with this work.

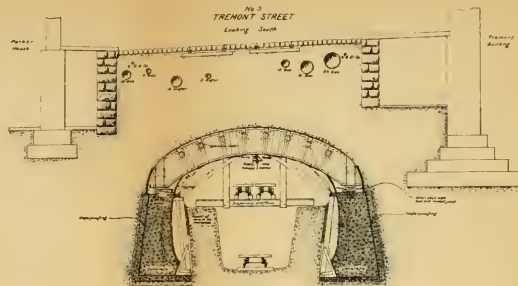
METHODS OF CONSTRUCTION.

The uncompleted portion of the work north of School street was continued on the "slice" system, and the same method was used for a length of 138 feet north of Park street. The intervening section, 550 feet long, was tunnelled with the aid of a roof shield, referred to later. The ventilating chamber in King's chapel burial-ground was built in tunnel, starting from one of the subway "slices," the masonry being built at same time as that of the "slice." The two methods are described below.

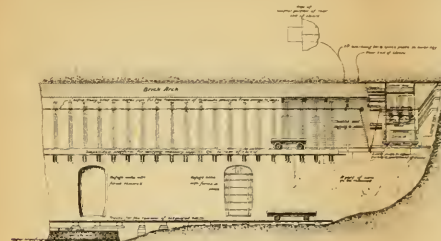
(a.) *Slice System.* — North of School street, where side-walls had been built in tunnel by the contractor, excavations were made between these side-walls, from the street surface, sufficiently deep to admit of turning the brick arch, leaving a lower core of earth to be taken out later. For the latter purpose a shaft, or opening, in the subway arch was left opposite the northwesterly end of King's chapel burial-ground. Conveyors for the removal of earth extended along Tremont street and across the burial-ground to Court square, where teams were loaded with earth in the daytime. At night the teams were loaded on Tremont street direct from the conveyor buckets. At the southerly end of the section the excavated material was handled by a conveyor which carried it to a hopper at Park street. Openings left in the subway arch in front of Park-street church served for the removal of earth and the supply of all materials required for the tunnel work in this vicinity. These were in the sidewalk, and measured 12 feet in length by 4 feet in width. In general, excavation proceeded uniformly day and night. Forms and centres were set during the day, and brick and



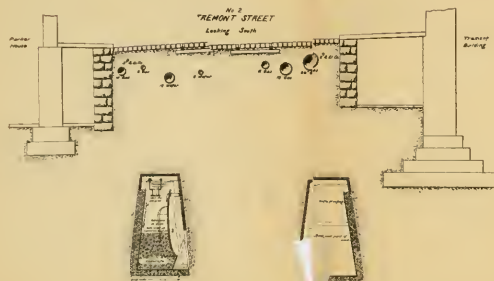
Plan section showing side drifts



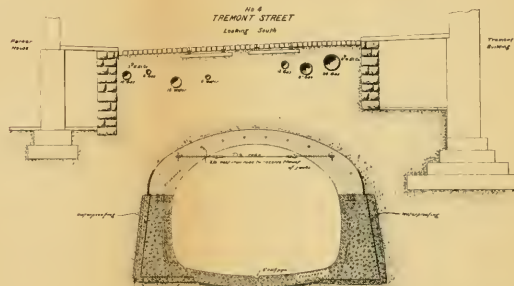
Cross section of head end of shield



Longitudinal vertical section through Street and Subway



Cross section indicating method of procedure - drifts



Cross section of completed Subway

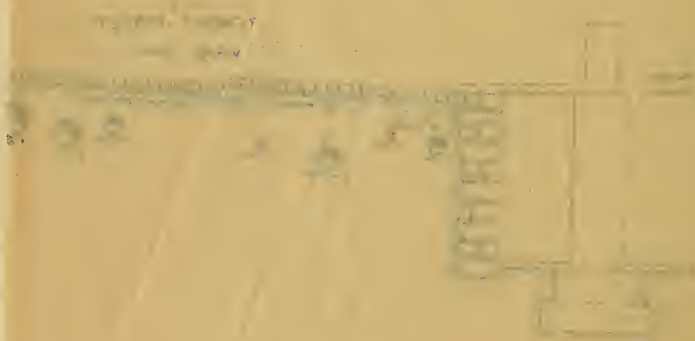
SECTION 6



TREMONT ST

TYPICAL CROSS SECTIONS OF THE SUBWAY SHOWING DIFFERENT STAGES IN THE PROGRESS OF THE WORK

Scale
1" = 20' HORIZ. & 1" = 10' VERT.



concrete work was done at nights and on Sundays. The building of bridges was done entirely at night.

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(b.) *Tunnelling by Shield.* — Where the roof-shield was used the side-walls were first built in small drifts and the excavation for the arch, instead of being done from the surface, was effected under the roof of the shield. Its rear end formed the necessary support for the earth while the arch was being built under it. For a length of 132 feet north of Park-street church the side-walls were built in double-tunnel, *i.e.*, a small tunnel drift one-half the height of side-wall was driven first and masonry carried up to half the height of wall, the upper half being built in a separate drift following on the lower. In the remaining 418 feet single drifts were driven sufficiently high for the whole side-wall to be built at one operation, as shown on Plate 21. In both cases, after the tunnels were driven, and before starting the masonry of the actual side-walls, the spaces between tunnel frames, formed by the timber caps and legs, were filled with concrete, flush with the inside face of frames, all lagging being removed as the concrete was put in. In this way cavities behind the lagging were effectually avoided and a perfect junction insured between the subway masonry and the adjacent undisturbed earth. The internal plane surface of the concrete was then plastered with Portland cement, and this in its turn was coated with asphalt waterproofing. The true side-wall of the subway was next built against this waterproofed surface. The "track" used for the shield to slide upon was imbedded in the top of the side-walls, and consisted (on each wall) of two 10-inch I-beams, connected by a bottom plate 12 inches wide by 1 inch thick, riveted to the flanges, on the upper flanges of which the cast-steel shoes of the roof-shield rested. These shoes had rounded lower edges, and were connected with the shield by ball and socket joints. (See Plate 21.)

A roof-shield (differing from the modern tunnel-shield by omitting the lower half of the latter) was unsuccessfully tried on the Baltimore Belt Railroad in 1892.

A roof-shield having an exterior width of 23.78 feet was employed in the construction of the upper arch of a portion of a Paris sewer (*Collecteur de Clichy*). This was begun in August, 1895, and finished in October, 1896, and is described in *Le Genie Civil*, April 25, 1896. This Paris shield rested and moved on rollers which in turn rested and moved on longitudinal timbers. The rams which moved it forward reacted against a series of centres on which the masonry arch was turned. The work in connection with this shield was very successfully and skilfully carried out. In the second

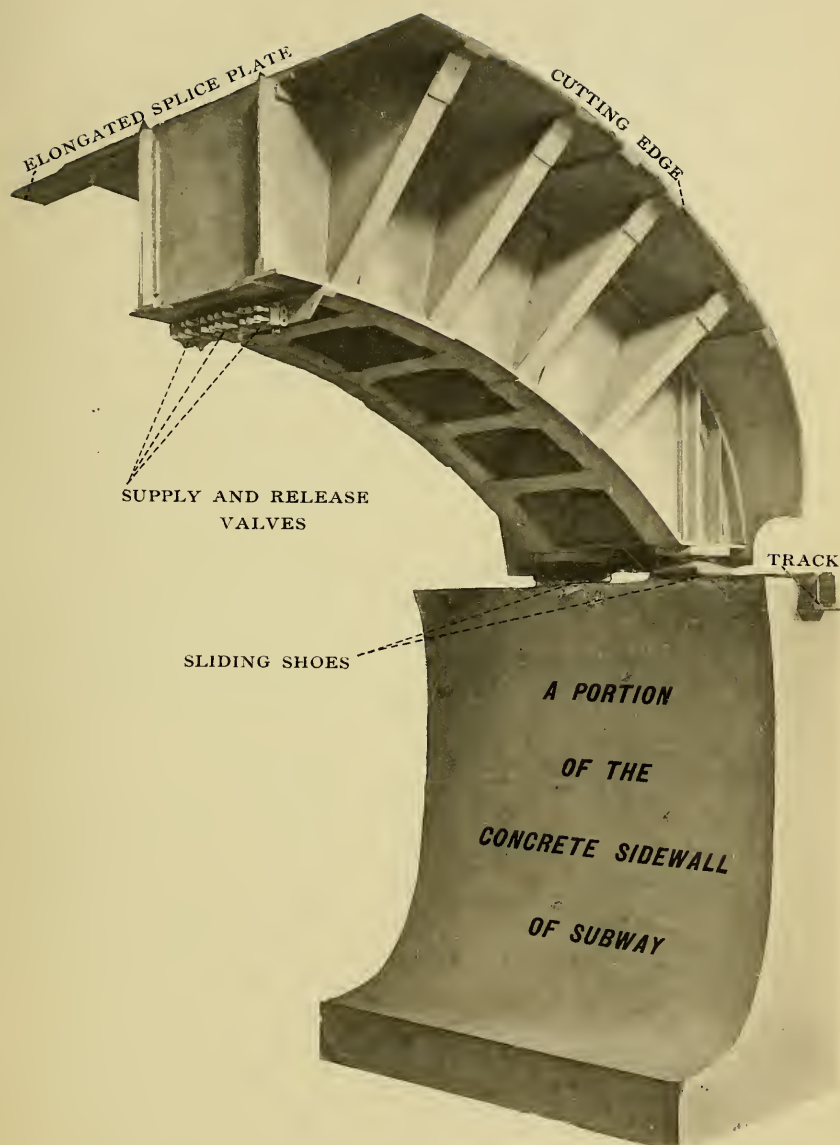
Report of
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contract for the *Collecteur de Clichy* a complete shield (as distinguished from a roof-shield) was used.

A design for a roof-shield for use on the subway was made in the Engineering Department early in April, 1896. This design embodied two heavy transverse girders, segmental in shape, track to be placed in the side-walls, and cast-steel shoes (without ball and socket joints) for running thereon. A modification of this design for possible use on Section 6 was made later in the same month, and in July, 1896, when it had been determined to complete the work on Section 6 directly instead of by contract, a final design was made. As finally designed the shield was an arch-like structure, 12 feet long, with a rise of 8 feet $7\frac{1}{4}$ inches in its outer span of 29 feet 4 inches. This is thought to be a wider single shield than any that has hitherto been successfully used. The aggregate width, however, of the frames constituting the shield used by Brunel more than seventy years ago was 38 feet. The shield used on Section 6 was built around two arched girders each 3 feet 8 inches deep, placed 4 feet apart, leaving 4 feet of overhanging plates at front and back. The space between the girders was divided into 10 compartments by $\frac{3}{8}$ -inch steel-plate diaphragms, and a 6-inch hydraulic jack was placed in each compartment, the whole controlled by a suitable arrangement of valves. The jacks were cast-steel cylinders, $10\frac{1}{2}$ inches in outside diameter, fitted with 6-inch pistons. The weight of the shield was about 22 tons. It was calculated to sustain an approximate load of 640,000 pounds. The cost of the shield and appurtenances was about \$6,000.

The motive power for actuating the shield was supplied by a line of 1-inch hydraulic pipes running from the force-pump to the valve-chamber of shield, fitted with a folding-joint pipe to admit of the necessary forward travel. The pump was placed in the subway at the bell-mouth opposite Park-street church, and electrical connections were provided between this point and the working face, so as to signal the required movement of the shield. The maximum pressure in the hydraulic jacks was 3,000 pounds per square inch, but this was used on only one or two occasions, a pressure of 1,200 pounds being usually sufficient. The rams of the jacks reacted against cast-iron rods $2\frac{1}{4}$ inches in diameter, built into the brickwork of the completed arch at proper intervals in its circumference. The greatest freedom and accuracy of manipulation were found possible by the arrangements described, the control of the valves being particularly effective in correcting slight changes of direction, overcoming uneven resistances, and in travelling around curves. Usually less than an hour sufficed to move the shield ahead a distance



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MODEL OF HALF OF ROOF-SHIELD AND PART OF SIDEWALL. ADVANCE
END OF SHIELD.

of 2.90 feet, set the centre, and otherwise prepare for the brickwork. Under normal conditions about three moves were made in 24 hours. As the shield moved forward, the 1-inch space over the arch masonry, due to the thickness of shield-plates, was filled by cement grout (pumped through pipes left in the brickwork), so as to make a close connection with the earth above. The depth of cover from the surface of the street to the top of the shield varied from 10 to 13½ feet.

Report of
Chief
Engineer.
Section 6.

The constructions alluded to above are the only cases known to the writer where a modern shield has been used in connection with a masonry tunnel. In most cases the walls of the tunnel in the rear of the shield have been made of cast-iron plates bolted together.

About 450 feet of the total distance traversed by the shield was in ground composed of closely compacted clay and sand, unfavorable to rapid progress. Boulders up to about 4 feet diameter were encountered. The remaining 100 feet length was in loose sand and gravel, necessitating direct forcing of the shield against the undisturbed face of the heading, instead of diminishing the resistance by cutting out the earth somewhat in advance of the shield, by miners, as was practicable elsewhere. The rate of progress in the two classes of ground did not vary materially. On the completion of the shield work, by making connection with the brick masonry of "slice" section at School street, all detachable parts of the shield, such as valves, rams, and connections, were removed, the steel girders and frame of the shield being bricked into the work.

Shield Method Data.

Hydraulic jacks made by Watson-Stillman Co., New York City.

Roof-shield built by James Russell Boiler Works Co., South Boston.

Shield erected in place	Dec. 30, 1896
Excavation under shield begun	Jan. 1, 1897
Masonry under shield begun	Jan. 7, 1897
Excavation under shield finished	April 2, 1897
Masonry under shield finished	April 16, 1897

Force employed. — The force employed on direct work varied with the character of the operations, but the average was about 125 men and 8 double teams by day and 85 men and 8 double teams by night. The shifts were of 10 hours each except from January 1 to April 18, 1897, after which 2 11-hour shifts were worked. The following table shows the rate of progress, etc. :

Report of
Chief
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Progress.

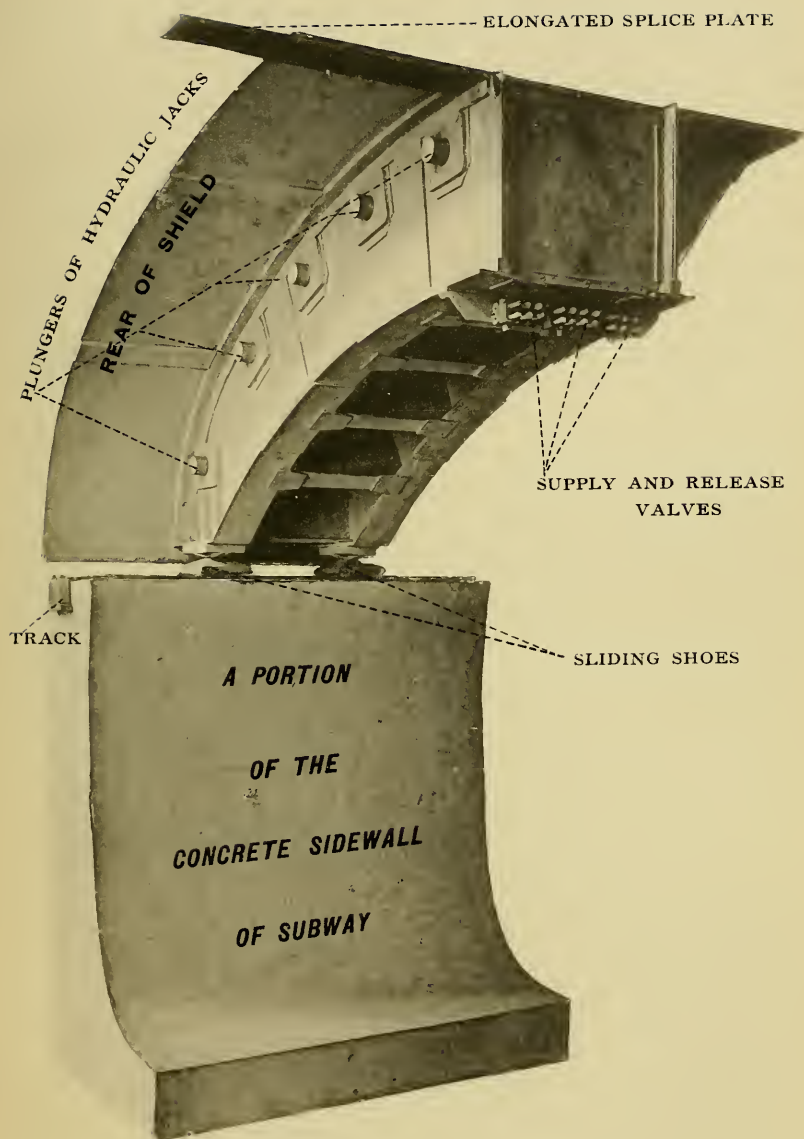
Section 6.

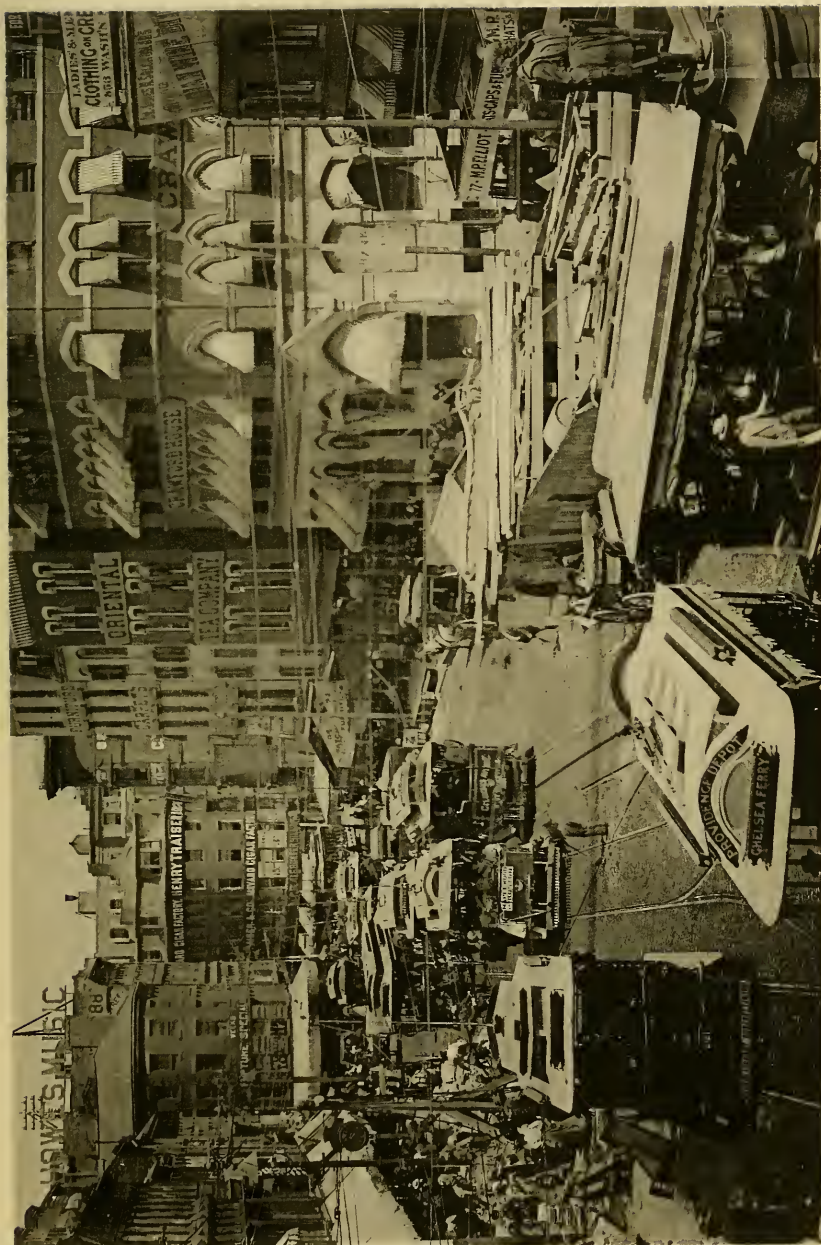
ITEMS.	Amount of work done previous to Aug. 15, 1896.	Date of completing.	Amount of work during year ending Aug. 15, 1897.	Total amounts from beginning of work to date, Aug. 15, 1897.
	<i>Cubic yds.</i>	<i>1897.</i>	<i>Cubic yards.</i>	<i>Cubic yards.</i>
Excavation	4,862	April 20	26,850	31,712
Steel erection	14 tons	April 16	170 tons	184 tons
Portland concrete	1,620	May 19	6,232	7,852
Rosendale concrete		May 19	348	348
Brick masonry	451	May 19	2,991	3,442
Plastering		Jan. 20	5,500 sq. yds.	5,500 sq. yds.
Waterproofing		Jan. 20	5,500 sq. yds.	5,500 sq. yds.

Character of Excavation. — The excavation was mainly through sand, clay, and stones, mixed in varying degrees of compactness. From a point about 100 feet south of Beacon street to Beacon street the excavation for the subway arch was through gravel, and the ventilator excavation (in tunnel) was sand and gravel. Only a very small volume of ground water was encountered. Storm water found its way from the surface through openings in the bridging over "slices," and was pumped into the sewers. No under-drain was used.

Accidents. — In addition to casualties of a minor character there were one serious accident and one accident resulting fatally. During the night of September 16, 1896, Charles McMullen, a laborer, who had only begun work on the subway that evening, stepped backward through the shaft of the conveyor at Park-street church, and fell to the bottom of shaft, a distance of about 42 feet, and died before he could be removed. Four days later William Doherty, a laborer, coming up out of the shaft in front of the Tremont building, slipped off the ladder and fell about 30 feet before striking against a bucket at the bottom. His injuries were of a very serious character, and included the loss of an eye, but he eventually recovered.

Present Condition of Work. — At the date of this report, August 15, the subway proper is structurally completed, but the surface finish has not yet been applied to the interior. Two shafts, left for purposes of construction, are yet to be filled in, and the removal of the two conveyors on Tremont street has not yet been begun, as they are still being used in connection with the work on Section 7.





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BOSTON TRANSIT COMMISSION

SECTION 7.-- SCOLLY SQUARE, LOOKING NORTH. CONSTRUCTING SIDEWALLS. JULY 15, 1897.

WORK DONE ON Section 7 OF THE SUBWAY FOR THE YEAR
ENDING AUGUST 15, 1897. (DIRECT WORK AND CONTRACT.)

Report of
 Chief
 Engineer.
 Section 7.

Location.—In and near Scollay square, connecting with Section 6 in Tremont street, Section 8 in Hanover street, and Section 8½ in Cornhill. The section includes a station known as Scollay-square station.

Contractors for Steel Work.—THE CARNEGIE STEEL COMPANY, LIMITED, Pittsburg, Pa.

Contractors for Construction.—SHAILER & SCHNIGLAU COMPANY, of Chicago, Ill. ROBERT P. LAMONT, Engineer and Secretary of the firm, has acted as Superintendent.

City Assistants.—John E. Palmer, Assistant Engineer; G. Herbert Brazier, Draughtsman; Robert B. Farwell, Transitman; George M. Stevens, Howard E. Smith, Thomas W. Bailey, and George P. Cowan, Assistant Transitmnen; E. Everett Gibbs, Rodman; Samuel Corning, Inspector of Masonry (contract work); Charles R. Gow, Day Foreman on Direct Work; John W. Linzee, Inspector on Contract Work; Charles F. Hall, Inspector of Steel Erection; John E. Newlands and J. T. Reid McManus, Assistants on Steel Work; A. E. Weaving, Principal Night Foreman (direct work); William C. Burnham and Charles J. McCarty, respectively Day and Night Timekeepers (direct work).

	Bids opened.	Date of contract.
Steel work	April 7, 1897.	April 12, 1897.
Construction	May 12, 1897.	May 15, 1897.

General Description of Structures.—A reference to the progress map shows that the section is triangular in shape, the greater portion of the main length being taken up by the station. This is about 306 feet long, with its wide end opposite Pemberton square. The island platform between the two single tracks is 19 feet wide at the northerly stairway and 39 feet at the southerly stairway, widening out with the station structure so as to form a transverse platform 158 feet long for the line of cars running from Tremont street across the square to Cornhill. The junction of the section with Section 6 in Tremont street is effected by a steel and concrete masonry bell-mouthed structure about 44 feet long, having a brick arch of uniform height throughout, but varying in width from 23 to 28 feet.

The work was done partly under the direct control of the Engineering Department and partly by contract. Throughout this report the former is referred to as direct work and the latter as contract work. The side-walls were constructed by direct work along those parts of the section where important buildings and other structures were in close proximity to the work. Curved side-posts were used

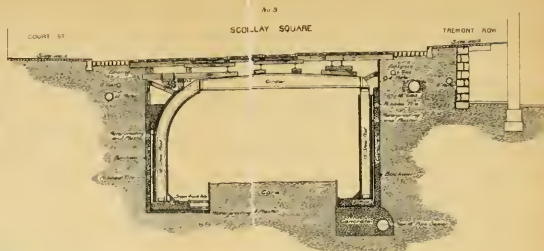
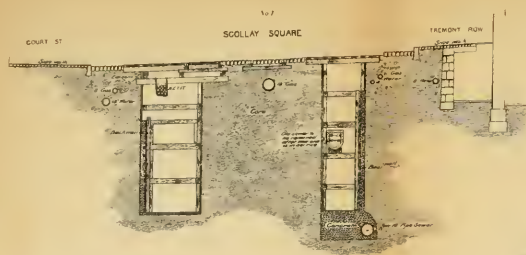
Report of
Chief
Engineer.
Section 7.

in these localities in order to afford space for a permanent location for water and other pipes. The total length of side-walls thus treated is 525 feet. The length of side-walls with vertical posts, built wholly by contract, is 704 feet.

The bell-mouth in Tremont street was built solely by direct work. Except where otherwise stated, none of the following description applies to this portion of the work, and the tables on pages 44 and 45 do not include it. The progress and other data on the bell-mouth are given on a separate table on page 46.

It was necessary to construct a new pipe-sewer on each side of the subway in Hanover street, in continuation of those constructed on Section 8. These replace the original sewer in the centre of the street, and are laid below the invert level of the subway, so as to provide for deep basements in future buildings. The sewer on the north side is 12 inches in diameter, and on the south side 18 inches. The latter passes underneath the subway structure at a point about 39 feet from the easterly end of the section, and forms a junction with existing sewers on Tremont row by means of a drop-manhole. A new 18-inch pipe-sewer, built into the back-wall of the subway, takes the place of an old brick sewer along Tremont row. It is laid about 7 feet below the intended rail level of the subway. For a distance of 43 feet near Pemberton square, where the sewer is laid on a curve, it is enlarged to a 24-inch brick-sewer, to facilitate inspection and cleaning. A 12-inch pipe-sewer was laid in the southerly back-wall of the subway in Tremont street. The total length of new sewer constructed in connection with this section is 630 feet, with six manholes at changes of line or grade. The sewer changes were made partly by direct work and partly under the construction contract.

Method of doing Work.—The method adopted for excavating side-wall trenches and erecting side-walls was the same in both direct and contract work. Small movable derricks, on wheels, and inclines were used to excavate a trench about 10 feet wide. It was found practicable to open this trench in a continuous length, except where the line of wall, at the corner of Cornhill and Court street, came too close to buildings. At this point alternating "pockets" about 18 feet in length were excavated, the intervening lengths not being opened out until the earlier lengths were completed and secured. The "pockets" and continuous trenches were bridged by suitable timbers, so as to provide for continuous street travel. The method of putting in 8-inch back-walls, setting steel side-posts, build-



SECTION 7

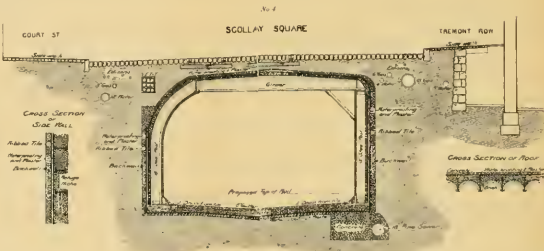
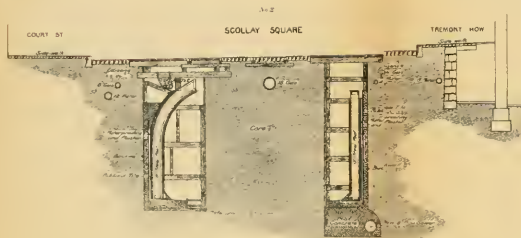


SCOLLAY SQ

TYPICAL CROSS SECTIONS OF THE SUBWAY SHOWING DIFFERENT STAGES IN THE PROGRESS OF THE WORK

1/4" = 1' 0" 2' 0" 4' 0" 8' 0" 16' 0"

Scale



ing side-walls, and the necessary portions of invert on which these rest, was essentially the same as described under Section 8. (See Plate 25, illustrating the successive stages of construction, Section 7.)

Report of
Chief
Engineer.
Section 7.

As soon as a sufficient length of opposite side-walls had been completed, the intervening earth was removed, in "slices," to a depth of 6 feet, to allow of the steel roof-beams being laid across. This work was mainly done at night. It was found that spaces varying from 20 to 30 feet in length could be opened up in a single night, so as to allow of the lowering of roof-beams into place and the bridging of the street surface by a 4-inch plank flooring in time for the resumption of traffic next morning. As soon as the roof-beams were riveted in place, the brick jack-arches were turned between them, and this was succeeded by the concreting, plastering, and waterproofing of the roof. The temporary bridging and flooring were then removed, enabling the backfilling and repaving of the street to be proceeded with.

The earth core beneath the roof-beams was excavated directly into carts and hauled through the completed portions of the subway (Sections 8, 9, and 10) and up the temporary incline at the northerly end of Section 10 to the street, and thence to the dumps provided. In the ordinary single-span portions of the work this operation was free from any complication due to interior columns, but in the wider station section it was essential to provide for the erection of the necessary columns before the roof-beams could be permanently secured across the entire span. Timber trusses, with footings on the base of the side-walls, were erected at intervals of 12 feet to support the longitudinal steel girders until the columns could be set up. (See Plate 27.) These separate girders, each long enough to span its intended pair of columns only, were held together by 24-foot hard-pine scarf pieces, two to each connection, 8-inch $\times$ 12-inch cross-section, secured to the sides of the girders with heavy clamps and bolts, so as to form continuous girders. One end always rested upon the undisturbed bank of earth in front, the other end was connected to the completed work behind, and the intermediate portion was supported by the temporary timber trusses. The granite footing-stones were then set and the interior columns erected upon them; this being done, the weight of the girders, roof-beams, and bridging could be transferred to the columns, and the temporary trusses and scarfing were accordingly removed. The steel work was then riveted together, and the construction of jack-arches, etc., followed in the ordinary course.

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Section 7.

The concrete invert consisted, as in other sections, of a lower course of Portland concrete, 4 inches thick, the upper face waterproofed. The true invert of Portland concrete, 12 inches thick, was laid upon this, finished to the proper lines, and a gutter formed in the centre.

Both direct and contract work were carried on continuously, day and night, in two shifts. The length of direct work shifts was 10 hours and of the contract shifts 11 hours each. The ordinary force on day work consisted of 55 men and 6 double teams during the day, increased at night to 60 men and 8 teams. Direct work began on May 3, 1897, and is still in progress at this date (August 15, 1897). Contract work began May 22, 1897, and is likewise still in progress. The ordinary day force on contract work has been about 55 men and 6 double teams. The night force was about 70 men and 10 teams.

The two tables annexed afford data as to progress, amount of work, etc., on direct and contract work respectively, not including bell-mouth. From the first of these it will be seen that the bulk of the direct work, including all excavation and steel erection, was completed before the close of the year under review.

Progress on Direct Work.

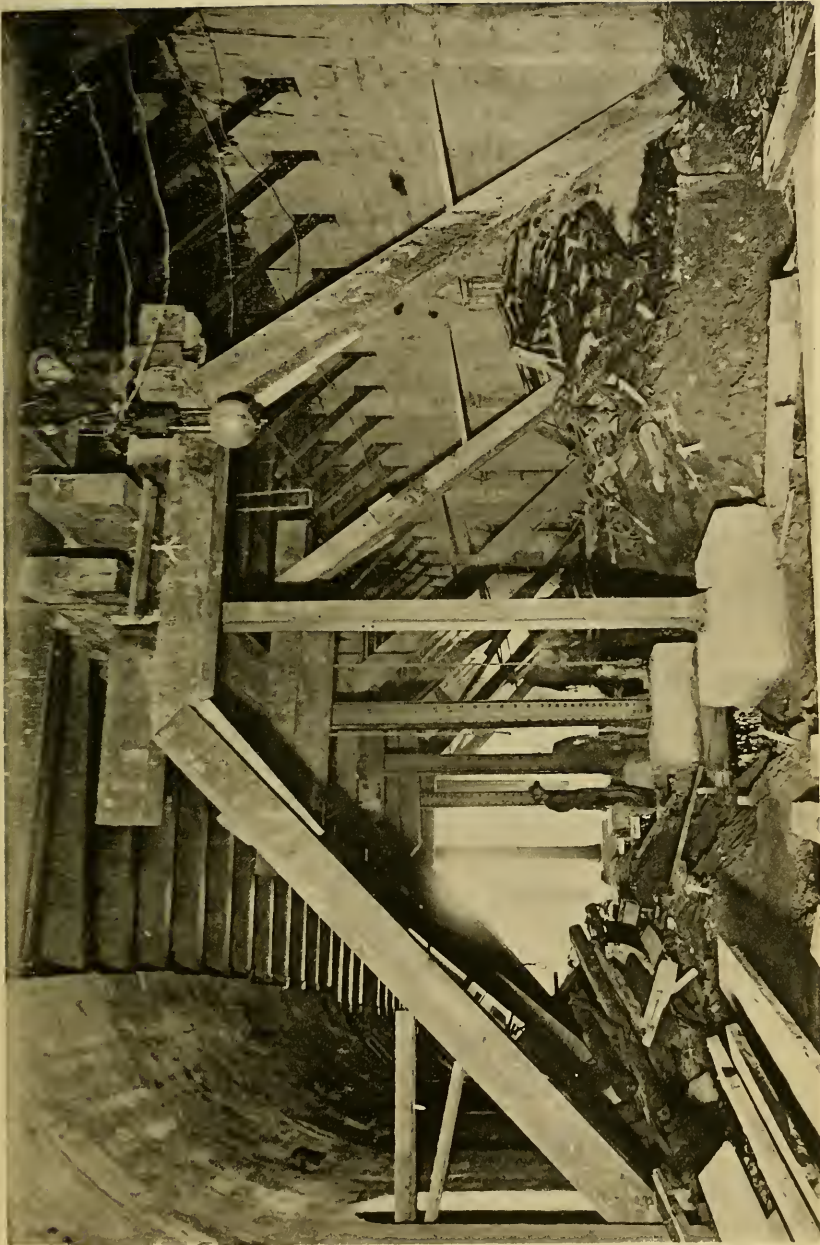
ITEMS.	Date of beginning.	Amount of work during year ending Aug. 15, 1897.	Average rate of progress per week during respective working periods, year ending Aug. 15, 1897.	Estimated total quantities in section (direct work).
	1897.	Cubic yards.	Cubic yards.	Cubic yards.
Excavation	May 3	4,550	325	4,550
Steel erection	May 28	118 tons	10.5 tons	118 tons
Concrete walls	May 19	1,113	88.5	1,336
Brick masonry	May 22	31.5	2.5	36
Plastering	May 27	1,580 sq. yds.	138 sq. yds.	1,580 sq. yds.
Waterproofing	May 27	2,000 sq. yds.	175 sq. yds.	2,000 sq. yds.
Rib-tiling	May 27	480 sq. yds.	42 sq. yds.	480 sq. yds.



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SECTION 7. UNDER SCOLLY SQUARE, SHOWING CURVE FROM HANOVER STREET. AUGUST 12, 1897.



BOSTON TRANSIT COMMISSION

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SECTION 7. UNDER SCOLLAY SQUARE DURING CONSTRUCTION, SHOWING BRACING, LOOKING SOUTHERLY. AUGUST 12, 1897.

*Progress on Contract Work.*Report of
Chief
Engineer.

Section 7.

ITEMS.	Date of beginning.	Amount of work during year ending Aug. 15, 1897.	Average rate of progress per week during respective working periods, year ending Aug. 15, 1897.	Estimated total quantities in section (contract work).
	1897.	Cubic yards.	Cubic yards.	Cubic yards.
Excavation	May 22	10,288	867	18,200
Concrete invert	August 1	309	155	1,325
Granite footing-stones	August 5	27	21	50
Steel erection	June 14	279	32	580
Concrete walls	May 25	1,103	94	1,140
Brick masonry	June 17	86	7	325
Concrete in roof	July 8	169	31	720
Plastering	May 28	3,429	301	7,400
Waterproofing	May 29	3,388	304	7,400
Rib-tiling	June 1	842	79	842

Removal of Statue.—The statue of John Winthrop, in Scollay square, being over part of the permanent work of the section, was removed to a new permanent location, approved by the Mayor, about 35 feet northeasterly from its original position. The work of removal was done by O. A. & G. A. Trumbull, under a separate contract dated June 30, 1897.

Bell-mouth.—The construction of the bell-mouth connecting this section with Section 6 was done by direct work in charge of Assistant Engineer H. H. Marden, Jr. Michael Tallent acted as night foreman until June 29, 1897, and thereafter C. H. Smith. The "slice" method of construction was used, as described under Section 4. In order to prevent anticipated leakage from a 20-inch $\times$ 28-inch brick sewer adjoining the work at an elevation of about 11 feet above the bottom of subway excavation, the sewer was broken into through the cellar floor of the Chadwick building and a 12-inch sheet-iron pipe laid through the sewer, surrounded by cement mortar. A 24-inch gas-main was removed to allow hoisting earth from below. Work was carried on continuously by a force of about 17 men during the day and double that number at night.

Report of
Chief
Engineer.

Progress Table (Direct Work), Bell-mouth Only.

Section 7.

ITEMS.	Date of beginning.	Date of completing.	Total amount of work in completed bell-mouth.
	1897.	1897.	Cubic yards.
Excavation	April 26	August 10	1,482
Concrete invert	August 11	August 14	74
Steel erection	June 1	August 4	21½ tons
Concrete side-walls	May 25	July 1	263
Brick masonry	July 9	August 4	113
Concrete spandrels	July 12	August 4	90
Plastering	June 1	August 5	506
Waterproofing	June 1	August 5	506

Character of Excavation. — Much of the excavation was in very fine dry sand and loose gravel, but stiff yellow clay was met with in Hanover street. At the corner of Tremont and Court streets, Cornhill and Court street, and Hanover street and Scollay square, the first 12 to 15 feet consisted largely of masonry area-walls, which required to be removed and replaced as the work progressed. The depth of excavation for side-walls ranged from 22 feet in Hanover street to 24 feet in Tremont street. The average depth on the part done by contract work was 22 feet. But little ground-water was found.

Section 8. **WORK DONE ON SECTION 8 OF THE SUBWAY FOR THE YEAR ENDING AUGUST 15, 1897. (CONTRACT WORK.)**

Location. — In Hanover street, from a point about 50 feet west of the westerly line of Washington street to a point about 100 feet east of the easterly line of Court street.

Contractors for Steel Work. — THE A. & P. ROBERTS COMPANY, Pencoyd Iron Works, Philadelphia, Pa.

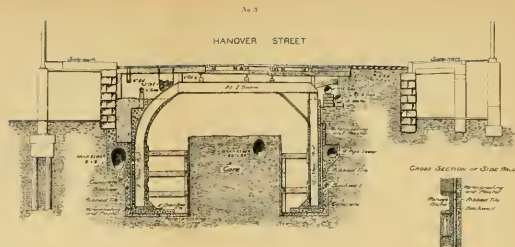
Contractors for Construction. — THE METROPOLITAN CONSTRUCTION COMPANY, Boston, Mass. GEORGE W. JUDD, Superintendent.

City Assistants. — John E. Palmer, Assistant Engineer (to December 1, 1896); Frank C. Shepherd, Assistant Engineer (from December 1, 1896); * Edward B. Roberts, * Carl S. Drake, Transitmen; Herbert D. Newell and Howard T. Manley, Rodmen; Arthur L. Sanborn, * Amos G. Robinson, and * Charles R. Gow, Inspectors of Masonry; F. Herbert Parker, Steel Inspector.

	Bids opened.	Date of contract.	Final certificate given.
Steel work .	Sept. 15, 1896.	Sept. 17, 1896.	Nov. 21, 1896.
Construction .	Oct. 6, 1896.	Oct. 8, 1896.	Mar. 19, 1897.

General Description of Structures. — This section consists of a two-track subway, with two air-intakes and one ventilating chamber. Its position and extent, with relation to the rest of the subway, can be seen on the progress map. The

* Part of the time only.



SECTION 8

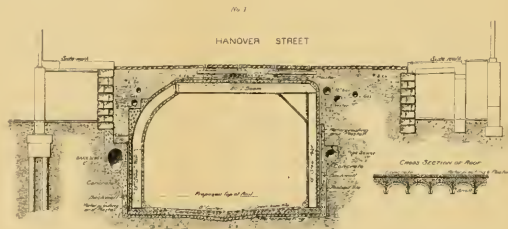
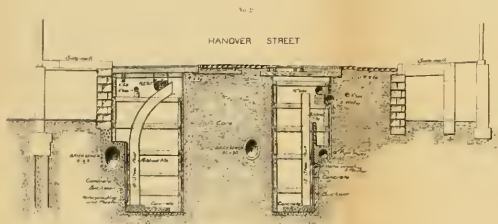


HANOVER ST.

TYPICAL CROSS SECTIONS OF THE SUBWAY SHOWING DIFFERENT STAGES IN THE PROGRESS OF THE WORK.

SCALE 1" = 10' HORIZONTAL 1" = 10' VERTICAL

Scale



subway is of the combined masonry and steel-work type, the framework being formed of steel posts at 3-foot intervals on each side, with steel roof-beams across the top. For a distance of 126 feet at the easterly end, towards Washington street, the southerly side-posts are curved at the top; at the westerly end the northerly side-posts are similarly treated for a length of 159 feet, the intervening length having vertical posts at each side. The tops of the posts are curved for the purpose of leaving a necessary space on the outside of the subway for water, gas, and other pipes. The side-walls are formed of Portland concrete masonry in which the steel side-posts are so imbedded as to leave a thickness of 2 inches of concrete in front of the posts. The walls are uniformly 21 inches thick along the vertical portion and 24 inches thick where curved side-posts are used. At intervals of 9 feet on each side of the subway refuge niches are hollowed out of the concrete side-walls. The ventilating chamber included in this section is a concrete structure placed under the sidewalk on the southerly side of Hanover street, near Marston's restaurant. The chamber for the reception of the fan and motor is connected with an opening in the street sidewalk, through which the air of the subway will be discharged by the action of the fan. This opening measures 24 feet 0 inches $\times$ 5 feet 3 inches in plan, and will be protected by a suitable iron grating at sidewalk grade.

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Engineer.
Section 8.

Near the westerly side of Portland street two air-intakes have been constructed, one on each side of the subway, with grated openings in the sidewalks measuring 10 feet by 4 feet. The structures are of concrete.

Four pipe-passages have been built in the roof of the subway at Elm street, in which pipes have been laid by the Boston Electric Light Company, the Brookline Gas Light Company, the city waterworks, and the Boston Low Tension Wire Association, respectively. The construction of the section involved the removal of old street sewers and the building of new ones, one on each side of the subway.

Methods of doing Work. — This work was largely done at night. The successive stages of construction may be briefly indicated (reference being made to folder, Plate 28), as follows:

(1.) Excavation in separate lengths of side-wall trenches (each about 18 feet long by 8 feet wide for straight walls and 10 feet wide for curved walls); earth conveyed by "inclines" to teams on street surface; street surface over trenches replaced by bridging.

(2.) Laid 4-inch lower concrete invert, from which was carried up back-wall of 8-inch concrete below sewer, and of

Report of
Chief
Engineer.
Section 8.

4-inch brickwork above sewer; sewers built in widened out back-wall; sheeting removed; placed coat of cement plaster on inner face of back-wall; placed continuous coat of asphalt waterproofing on back-wall and on lower stratum of floor of subway; laid part of upper stratum of floor of subway; laid ribbed tiling against asphalt waterproofed face of back-wall and cement plastered and asphalt waterproofed the ribbed tiling. The work indicated in the foregoing portion of this paragraph was carried on day and night, by removing part of the bridging. Lowered steel side-posts into trench during night and erected them upon strip of invert.

(3.) Built concrete side-walls between and around steel posts to about a foot below top of same; plastered and waterproofed upper portion of back of side-wall; backfilled trenches behind partially completed side-wall; niches left in wall every 9 feet and 2-inch drain-pipe laid from ribbed tile at base of column every 9 feet; earth excavated at night to a depth of about 9 feet the whole width between side-wall trenches; street bridged in time to accommodate morning traffic. The steel roof-beams were put in place during three Sundays by means of a small movable derrick — bridge between the two tracks being removed and car traffic being suspended.

(4.) Bolted the steel work and turned the brick arches between roof-beams without disturbing the bridging (see photograph, Plate 29); laying concrete roof over the brick arches and plastering and waterproofing on top, and placing the 3-inch concrete on top of waterproofing, done from the surface, mostly in night and somewhat on Sundays; earth remaining to be excavated (part of core) hoisted out through holes temporarily left in the roof, by "inclines" placed between curb and car tracks; laid middle strip of lower and upper strata of floor of subway; surface repaved, mostly during the day.

Services of pipes, conduits, etc., were uninterruptedly maintained. Street traffic was maintained at all times, except that cars were out of service from 11.30 P.M. to 6 A.M. (one track after 8 P.M. usually) and during the three Sundays already noted.

Work was commenced by the contractor October 11, 1896. The force ordinarily employed on the work consisted of 120 men and 7 double teams, equally divided between two shifts (day and night) of 11 hours each. The following table shows the rate of progress from that time until the practical completion of the section on March 19, 1897:



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SECTION 8. UNDER HANOVER STREET DURING CONSTRUCTION. TURNING BRICK ARCHES BETWEEN ROOF BEAMS (STAGE 4, PAGE 48). DECEMBER 31, 1896.



*Progress.*Report of
Chief
Engineer.

Section 8.

ITEMS.	Date of beginning.	Date of completing.	Average rate of progress per week during respective working periods.	Total quantities in completed section.
		1897.	Cubic yards.	Cubic yards.
Excavation	Oct. 12, 1896	March 14	576	12,596
Concrete invert	Oct. 19, "	Feb. 27	33	619
Steel erection	Oct. 29, "	March 3	18 tons	320 tons
Concrete walls	Oct. 19, "	March 15	77	1,625
Brick masonry	Oct. 24, "	Feb. 27	15	294
Concrete in roof	Jan. 7, 1897	Feb. 23	64	466
Plastering	Oct. 28, 1896	March 20	260 sq. yds.	5,333 sq. yds.
Waterproofing	Oct. 28, "	March 14	345 " "	6,747 " "
Rib-tiling	Oct. 28, "	Feb. 16	72 " "	1,140 " "

Character of Excavation. — The ground consisted of filling for the first 5 or 6 feet. The remainder was mainly blue clay, but between Elm street and the easterly end of the section some dry yellow sand was found. Very little ground water was encountered, but the under-drain laid by the contractor along the whole length of section was useful in dealing with rainfall and the flow of old sewers. A pulsometer worked during the whole time of construction, and a steam-pump part of the time. The need for these arose mainly from surface water and sewage.

WORK DONE ON **Section 8 $\frac{1}{2}$** OF THE SUBWAY FOR THE YEAR ENDING AUGUST 15, 1897. (CONTRACT WORK.)

Section 8 $\frac{1}{2}$

Location. — Cornhill, from about 20 feet easterly of the west line of Washington street to a point about 22 feet from Court street.

Contractors for Steel Work. — A. & P. ROBERTS COMPANY, Pencoyd Iron Works, Philadelphia, Pa.

Contractors for Construction. — THE NATIONAL CONTRACTING COMPANY, of New York City. MARK WILMARTH has acted as General Manager.

City Assistants. — F. B. Edwards, Assistant Engineer; G. M. Bacon, Principal Transitman; F. H. Morris, Transitman; W. E. Watkins and L. D. Tracy, Rodmen; W. M. Bailey and W. A. Rogers, Inspectors.

	Bids opened.	Date of contract.	Final certificate given.
Steel work	March 1, 1897.	March 4, 1897.	January 8, 1897.
Construction	March 31, 1897.	March 31, 1897.	

General Description of Structures. — This section consists throughout its entire length of a two-track subway, similar to Section 8, already described.

The contract section includes a ventilating chamber, 28

Report of
Chief
Engineer.
Section 8½.

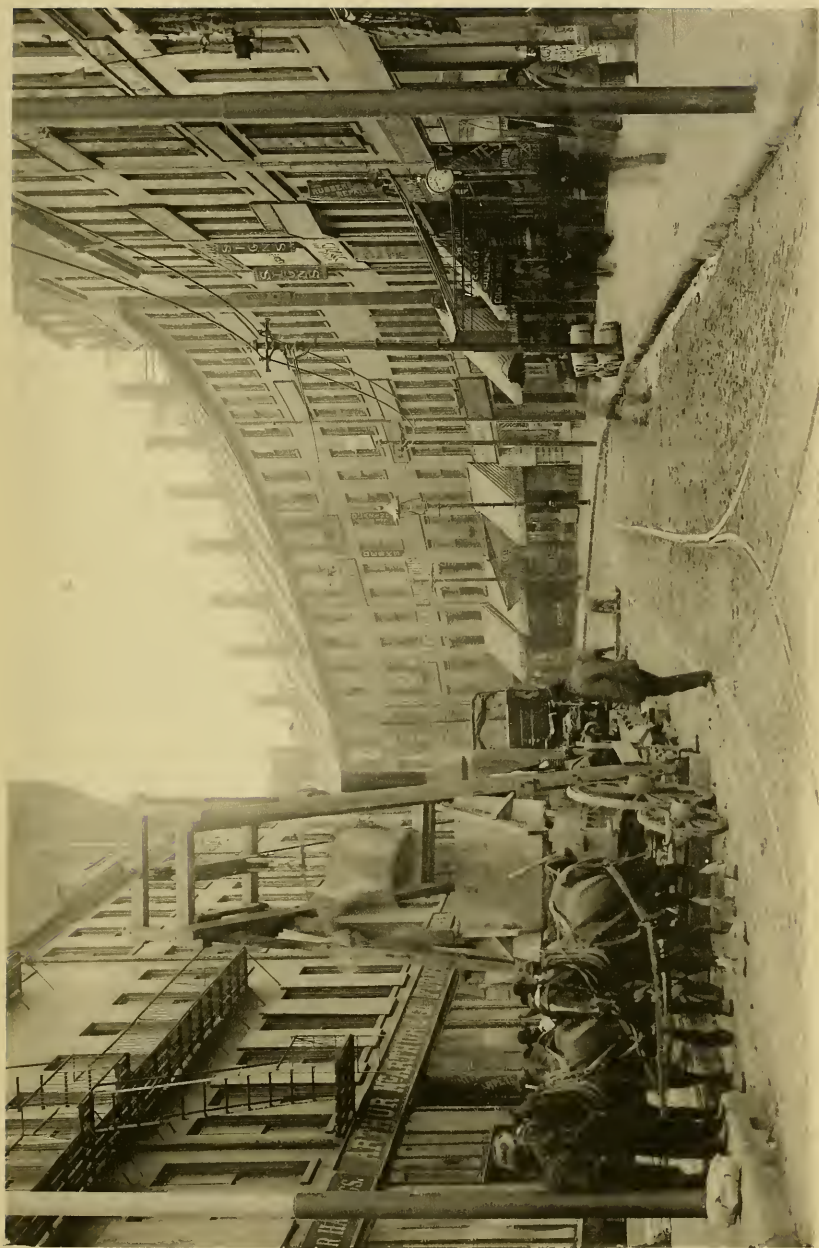
feet long and 6 feet wide, built under the sidewalk on the northerly side of Cornhill, about 37 feet west of Franklin avenue. It is a steel and concrete structure, and will eventually be covered with an iron grating level with the sidewalk.

The position and extent of the section in relation to the rest of the subway can be seen on the progress map. The structure varies from about 22 feet to 26 feet wide inside. The external width exceeds the distance between the street-curb lines, the average width of excavation being $28\frac{1}{2}$ feet. The average depth, from the street surface to the under side of invert, is about 22 feet.

It was necessary to remove the sewer in Cornhill from Washington street to near Scollay square. As the buildings on the north side are drained into a sewer in Brattle street and those on the south side west of Franklin avenue are drained into a V-shaped private sewer running under the sidewalk, it was only necessary to provide a new sewer for the buildings on the south side between Washington street and Franklin avenue. Between these points the excavation to the depth of the proposed sewer was made a little wider than required to build the subway. In this space was laid a 12-inch vitrified pipe imbedded in concrete. The trench above the sewer was filled with concrete forming the back-wall of the subway, and making it of greater thickness than generally constructed. The previously mentioned private V-shaped sewer was disturbed for 72 feet next the westerly end. A 10-inch vitrified pipe was substituted for the portion disturbed, laid in a similar manner as above described. The total work upon sewers on this section is as follows:

- 72 lin. feet of 10-inch vitrified pipe.
- 186 lin. feet of 12-inch vitrified pipe.
- 1 manhole.
- 1 lamp-hole.
- 1 catch-basin rebuilt.

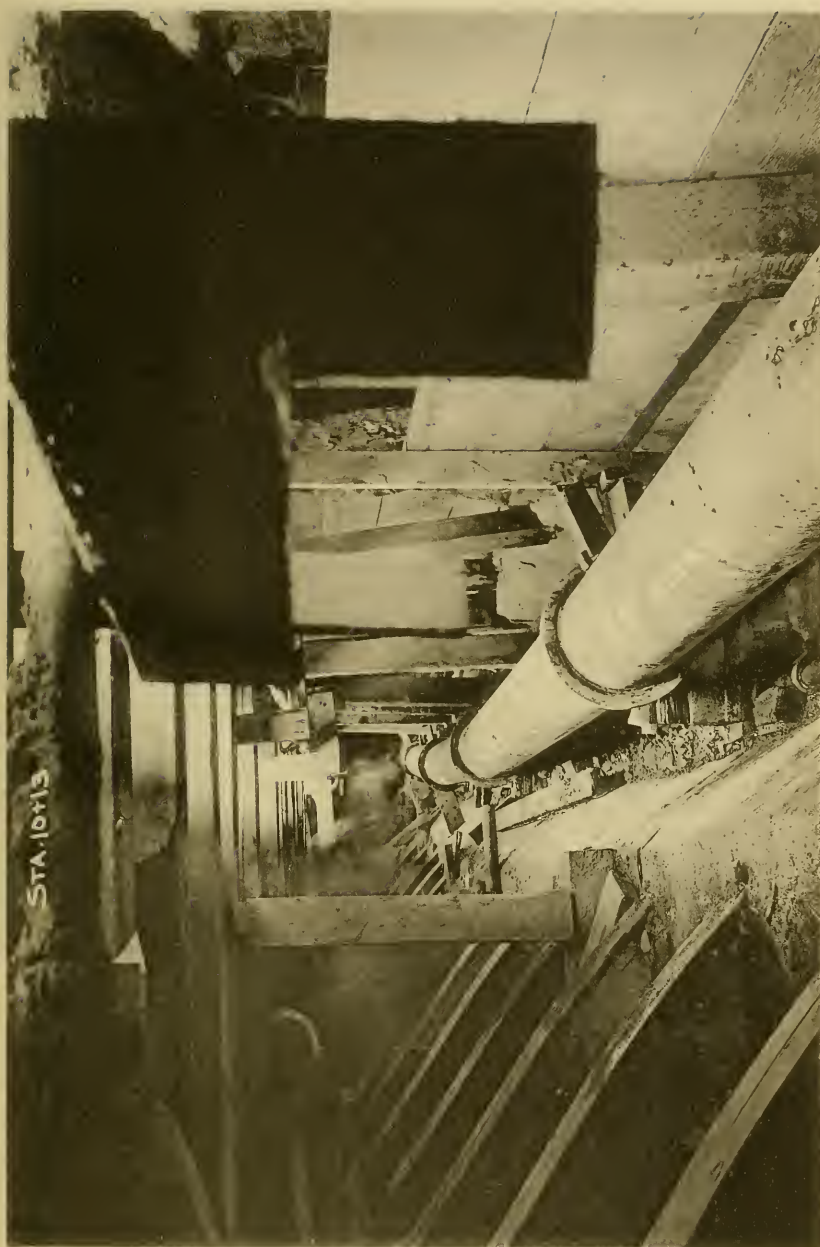
Method of doing Work. — The operations on this section greatly resembled those in Section 8. Work was carried on continuously (day and night) excepting only July 4 and 5 and the night of August 8. The following work was mostly or wholly done nights and Sundays: namely, opening of side-wall trenches, bridging of streets, setting steel roof-beams, asphaltting, concreting on the roof, and backfilling. Paving between track rails was usually done on Sundays, occasionally nights. The remaining operations were carried on with equal facility day or night.



THE HELIOTYPE PRINTING CO., BOSTON

BOSTON TRANSIT COMMISSION

SECTION 8 1-2. CORNHILL, LOOKING WESTERLY. EXCAVATED EARTH BEING DUMPED FROM INCLINE INTO CART. APRIL 29, 1897.



THE HELIOTYPE PRINTING CO., BOSTON

BOSTON TRANSIT COMMISSION

SECTION 8 1-2. 12-INCH WATER PIPE AND TOPS OF CURVED POSTS ON SOUTH SIDE OF CORNHILL,
LOOKING EAST. JULY 9, 1897.

Force employed, etc. — The number of men ordinarily employed was about 90, about equally divided into two shifts (day and night) of 10 hours each. An average of 6 double teams was employed during the day and 7 at night. The rate of progress, etc., is shown in the following table, from which it will be seen that the work is substantially complete. About one-half of the masonry in the ventilating chamber remains to be built.

Report of
Chief
Engineer.
Section 8½.

ITEMS.	Date of beginning.	Amount of work during year ending Aug. 15, 1897.	Average rate of progress per week during respective working periods, year ending Aug. 15, 1897.	Estimated total quantities in section.
	1897.	Cubic yards.	Cubic yards.	Cubic yards.
Excavation	April 25	10,122	662	10,122
Concrete invert	April 30	563	38	576
Steel erection	May 22	292 tons	24 tons	293 tons
Concrete walls	April 30	1,364	89	1,408
Brick masonry	June 19	195	24	195
Concrete in roof	June 21	374	48	376
Plastering	May 6	4,100 sq. yds.	285 sq. yds.	4,200 sq. yds.
Waterproofing	May 9	5,540 sq. yds.	396 sq. yds.	5,580 sq. yds.
Rosendale concrete	May 3	126	19	126
Rib-tiling	May 13	1,139 sq. yds.	190 sq. yds.	1,139 sq. yds.

Character of Excavation. — The first 6 feet in depth consisted of filling. Below this was blue clay, interspersed with thin bands of gravel at the Washington-street end of the section and fine sand at the Court-street end. But little ground water was encountered and no under-drain was laid. A pulsometer was maintained for about a month near Washington street, but was seldom used. Considerable surface water entered the trenches during rainstorms and drained off into the adjoining section (Section 9) in Washington street.

WORK DONE ON **Section 9** OF THE SUBWAY FOR THE YEAR ENDING AUGUST 15, 1897. (DIRECT WORK AND CONTRACT.)

Section 9.

Location. — In Hanover street, between Portland and Washington streets, thence along Washington street to and through Adams square to Cornhill and Dock square.

Contractors for Steel Work. — A. & P. ROBERTS COMPANY, Pencoyd Iron Works, Philadelphia, Pa. (Two contracts.)

Contractors for Construction. — RICHARDSON & YOUNG, Chicago, Ill. ROBERT B. MUIR, Superintendent.

City Assistants. — John E. Palmer, Assistant Engineer (direct work); Frank C. Shepherd, Assistant Engineer (contract work); Edward B. Roberts, Transitman in charge of lines and grades; Carl S.

Report of
Chief
Engineer.
Section 9.

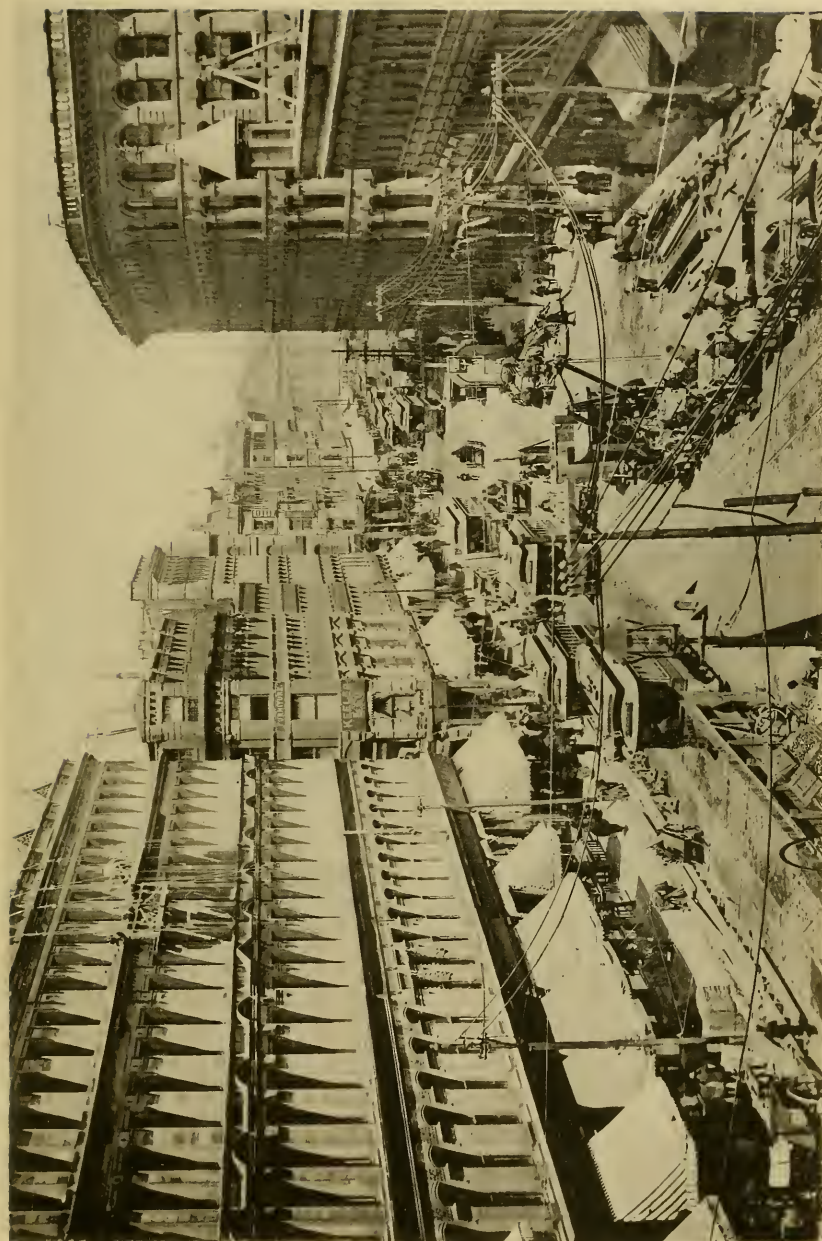
Drake, Transitman (estimates, etc.) ; William O. Wellington, Transitman ; Carl I. Crocker and Howard T. Manley, Assistant Transitsmen ; Herbert D. Newell, Amos G. Robinson, and George W. Jepson, Rodmen ; William Park, James E. Coyne, George H. Foss, Jr., and James W. Martin, Inspectors ; Charles R. Gow, Day Foreman on Direct Work ; F. Herbert Parker and Thomas J. Walsh, Inspectors of Steel Erection ; A. E. Weaving, Principal Night Foreman (direct work) ; W. C. Burnham and Charles J. McCarty, respectively Day and Night Timekeepers (direct work).

		Bids opened.	Date of contract.
Curved side-posts			October 15, 1896.
Other steel work		January 11, 1897.	January 15, 1897.
Construction		February 24, 1897.	March 6, 1897.

General Description of Structures. — The section consists mainly of a three-track subway with a station and loop at Adams square. Its position and extent with relation to other portions of the work can be seen on the progress map. Where the two-track portion from Hanover street converges into Section 10 on Washington street there is a short length of four-track subway with three rows of centre columns. The station is 220 feet long, with a maximum width of 104 feet. Work was done partly under the direct control of the Engineering Department and partly by contract. Throughout this report the former is referred to as direct work and the latter as contract work. Owing to the close proximity of buildings to the foundations and side-walls it was decided to put in the greater part of the side-walls by the former method, and 1,059 lin. feet of side-walls were thus built, as against a total of 704 lin. feet by contract.

In the portions built by direct work side-walls with curved tops were necessary to provide room for pipes ; the side-walls built by contract were all vertical.

A 24-inch brick sewer was built in the westerly side-wall of the subway along Washington street from Hanover street to Elm street, and continued as an 18-inch pipe-sewer to Brattle street. In Hanover street a 10-inch pipe-sewer was built in the northerly side-wall and a 2-foot $\times$ 3-foot brick sewer in the southerly wall. All of these sewers, amounting to 608 lin. feet in the aggregate, and including five new manholes, were built by direct work. About 67 lin. feet of 2-foot $\times$ 3-foot brick sewer, extending from the foot of Cornhill across Adams square towards Devonshire street, was interfered with. It was replaced by a 24-inch brick sewer laid outside of the southerly wall of the subway structure in a lateral extension of the back-wall. Two new manholes were built in connection with this work, which was done as part of the construction contract.



THE HELIOTYPE PRINTING CO., BOSTON

BOSTON TRANSIT COMMISSION

SECTION 9. -- ADAMS SQUARE, LOOKING NORTH. CONSTRUCTING SIDEWALLS. APRIL 13, 1897.



THE HELIOTYPE PRINTING CO., BOSTON

BOSTON TRANSIT COMMISSION

SECTION 9.--PIPES IN THE WEST SIDE OF WASHINGTON STREET,
LOOKING NORTH. MARCH 23, 1897.

Method of doing Work. — The method of putting in side-walls was usually that of continuous trenches described under Section 8. Alternating pockets, referred to in last year's report as being then in use on Section 10, were used in some places where buildings were very close to the work. The pockets were 10 feet wide, and varied from 12 to 18 feet in length. Small movable derricks, on wheels, and inclines were used for the excavation. The day work was substantially completed April 29, 1897, and the side-walls included in the contract work August 15, 1897.

Report of
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Section 9.

In a length of 60 feet at the northerly end of the section the subway includes (as already stated) three interior rows of columns, corresponding with the side-wall posts. The excavation for the two outer rows was done in trenches 6 feet wide, excavated at night by the small derricks already referred to, the street being bridged over as in the case of side-wall trenches. On the completion of the respective strips of lower and upper invert, with the necessary water-proofing between, the steel columns were erected on the upper invert. The earth between the trenches was then removed to a depth of about 4 feet below the surface, and the permanent roof-beams laid, on the one hand, from the outer columns to the side-walls, and, on the other, from the outer columns to the centre. Pending the erection of the centre columns, the overhanging ends of the roof-beams were temporarily supported by 10-inch $\times$ 12-inch longitudinal timbers placed under the beams 3 feet from their ends. These "stringers" rested at first upon the undisturbed earth cores left in place, and as the cores were removed during the subsequent operations timber uprights were inserted to take the weight.

The removal of the lower earth cores was effected by shovelling into teams which passed through the adjoining Section 10 and thence up the temporary incline at its northerly end.

In Hanover street there are no interior columns, the roof being in one span. The roof-beams were placed in position at one operation, by night work, the street surface being bridged over so as to accommodate the day traffic. In Washington street, south of Hanover street, the three-track subway has only one row of interior columns. These were erected as described above, the excavation being done from below. In all cases the removal of the earth cores, between columns, was carried in the first instance down to about 2 feet above grade only, the remainder being removed when the work of completing the invert was taken in hand. The brick jack-arches and concrete on top were put in during the

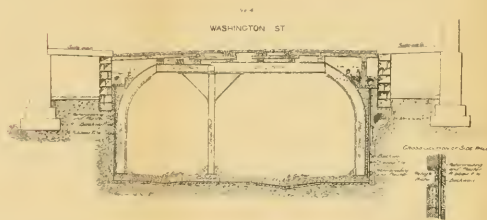
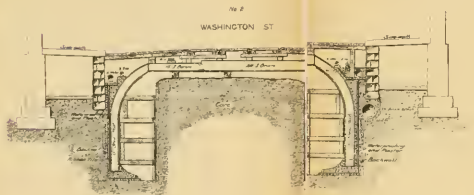
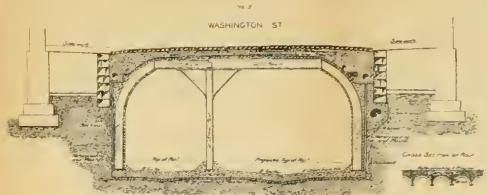
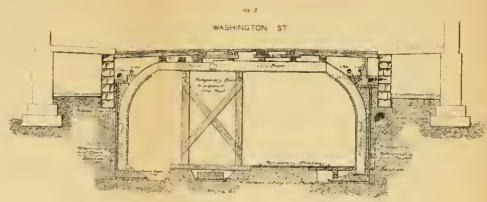
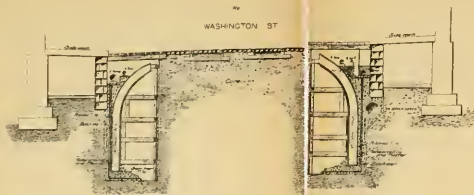
Report of
Chief
Engineer.

Section 9.

night, the street covering being removed and street-car tracks closed in sections as required, one track at a time. When this was done, the concrete side-walls, which had been left about a foot below the tops of the side-posts, were carried up to their full height by night-work. Following on this, the work of plastering and waterproofing the walls and completed roof was prosecuted day and night. The successive stages of work on this section are illustrated by Plate 34 and photographic view on Plate 32. The detailed description of the methods adopted on Section 8 applies to a considerable portion of the work on Section 9. Great care had to be exercised in excavating for and building the side-walls, to prevent the settlement of buildings. In some cases, as when masonry areas under sidewalks were interfered with, new area-walls of steel I-beams and concrete, 8 inches thick, were built to take the place of the original walls. In other cases steel I-beams were used to support foundations until the back-wall of the subway was carried up beneath them. Careful levels have been taken, at frequent intervals, on all buildings during the progress of the work up to the present time, and no indications of settlement have been observed.

Force employed. — The ordinary force on direct work consisted of about 140 men and 13 double teams, working two 11-hour shifts per day, divided into 60 men and 6 teams during the day and 80 men and 7 teams at night. The contract force consisted of about 140 men, equally divided into day and night shifts of 10 and 11 hours respectively. An average of 7 double teams by day and 12 by night was employed.

On August 15, 1897, the length from the northerly end of the section to Elm street was practically completed; from the southerly end of the section to the northerly side of Brattle street all the steel roof-beams were in place, and part of the roof (where there are no centre columns) finished. As already stated, both direct and contract work were carried on continuously day and night. The rate of progress, etc., on direct and contract work respectively, are shown in the following tables :



SECTION 9 WASHINGTON ST

TYPICAL CROSS SECTIONS OF THE SUBWAY SHOWING DIFFERENT STAGES IN THE PROGRESS OF THE WORK

Scale 1" = 10' 0"



BOSTON TRANSIT COMMISSION

THE HELIOTYPE PRINTING CO., BOSTON

SECTION 10. WORK ON HAYMARKET-SQUARE STATION, LOOKING NORTH. FEBRUARY 8, 1897.

*Progress on Direct Work.*Report of
Chief
Engineer.

Section 9.

ITEMS.	Date of beginning.	Date of completing.	Total quantities in completed section (direct work).	Average rate of progress per week during respective working periods.
	1896.	1897.	Cubic yards.	Cubic yards.
Excavation	Oct. 29	April 27	8,085	311
Steel erection	Dec. 6	April 29	204 tons	9.7 tons
Concrete walls	Dec. 1	May 2	2,250	102
Brick masonry	Dec. 15	April 20	85	5
Plastering	Dec. 3	April 29	3,032 sq. yds.	117 sq. yds.
Waterproofing	Dec. 4	April 29	4,514 sq. yds.	174 sq. yds.
Rib-tiling	Dec. 4	May 2	1,334 sq. yds.	63 sq. yds.

Progress on Contract Work.

ITEMS.	Date of beginning.	Amount of work during year ending Aug. 15, 1897.	Average rate of progress per week during respective working periods.	Estimated total quantities in section (contract work)
	1897.	Cubic yards.	Cubic yards.	Cubic yards.
Excavation	March 21	14,860	708	23,000
Concrete invert	April 6	664	35	1,800
Granite footing-stones	July 1	7	1	30
Steel erection	March 26	493 tons	24 tons	660 tons
Concrete walls	April 14	939	53	1,150
Brick masonry	May 13	267	20	500
Concrete in roof	June 2	533	50	974
Plastering	April 18	3,247 sq. yds.	191 sq. yds.	6,500 sq. yds.
Waterproofing	April 6	5,091 sq. yds.	273 sq. yds.	9,000 sq. yds.
Rib-tiling	April 25	1,011 sq. yds.	63 sq. yds.	1,100 sq. yds.

Character of Excavation. — From 5 to 7 feet of filling was found over the entire section. Below this was hard blue clay, with fine loose sand in places. At Brattle street and Cornhill coarse gravel was found below the filling, and more water was met with here than elsewhere on the section. Some trouble was experienced in the contract work on account of water from the trenches in which side-walls had previously been built by direct work, but generally the amount of ground water was small. A steam-pump on the direct work and a 3-inch pulsometer on the contract work were set up to deal with the surface water which found its way into the trenches. The average depth of excavation to the under side of subway invert was about 21 feet.

Accident. — On May 18, 1897, at 9.30 A.M., at the junc-

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tion of Hanover and Washington streets, one of the timber uprights supporting the longitudinal stringers described above was undermined, owing to the proximity of an old well filled with fine soft sand and water. The wooden post was canted out of position, causing the stringers to settle at the ends not supported by the solid earth core, and these brought with them the ends of the steel beams which rested upon them. The greatest settlement of stringers or beams amounted to 4 inches. Although no signs of settlement existed on the surface, the street-cars of one track on Hanover street and one track on Washington street were stopped and diverted until long "sills" and new posts resting thereon were inserted. The car traffic was fully resumed at 2 P.M.

Removal of Statue. — It was found necessary to remove the statue of Samuel Adams in Adams square about 5 feet to the north and $2\frac{1}{2}$ feet to the west, in order to make room for part of the side-walls. This was done by John Cavanagh & Sons under a separate contract dated May 5, 1897. The new position of the statue was approved by the Mayor.

Section 10. **WORK DONE ON Section 10 OF THE SUBWAY FOR THE YEAR ENDING AUGUST 15, 1897. (DIRECT WORK AND CONTRACT.)**

Location. — In Washington street, from the northerly end of Haymarket square, across Friend street to the northerly line of Hanover street.

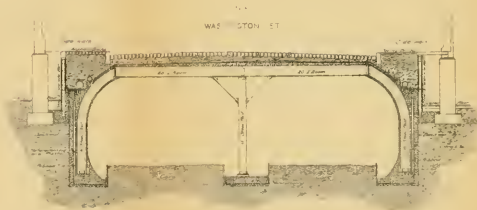
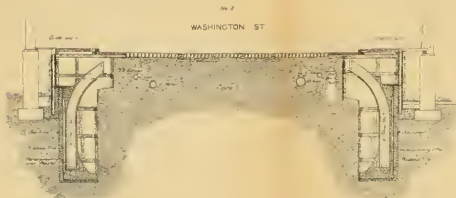
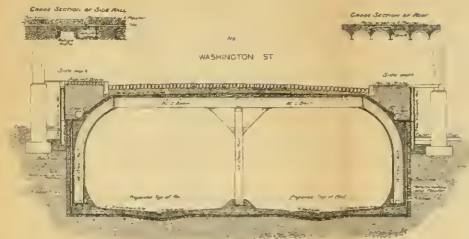
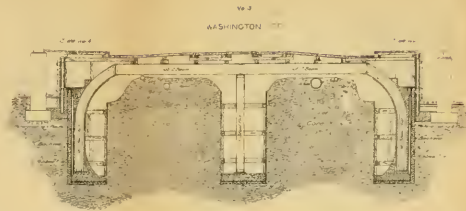
Contractors for Curved Steel Side-posts. — THE PENNSYLVANIA STEEL CO., Steelton, Pa.

Contractors for Steel Work for Station and for Subway Roof. — THE CARNEGIE STEEL COMPANY, LIMITED, Pittsburg, Pa.

Contractors for Construction. — SHAILER & SCHNIGLAU CO., Chicago, Ill. E. K. TRICKEY was Superintendent to January 10, 1897, when he was succeeded by ROBERT P. LAMONT, Engineer and Secretary of the firm, who continued to act until April 21, 1897.

City Assistants. — John E. Palmer, Assistant Engineer; Robert P. Farwell, Transitman; G. Herbert Brazer, Transitman and Draughtsman; George M. Stevens, Assistant Transitman; George W. Jepson, Francis P. Garland, and E. Everett Gibbs, Rodmen; Amos G. Robinson, James E. Coyne, and William Park, Inspectors; Charles R. Gow, Day Foreman on Direct Work; Charles F. Hall, Inspector of Steel Erection; J. T. Reid McManus, Assistant on Steel Work; A. E. Weaving, Principal Night Foreman (direct work); William C. Burnham and Charles J. McCarty, respectively Day and Night Timekeepers (direct work).

	Bids opened.	Date of contract.	Final certificate given.
Curved steel side-posts		July 28, 1896.	Oct. 10, 1896.
Steel in station			
and in subway			
roof	Aug. 6, 1896.	Aug. 11, 1896.	Nov. 11, 1896.
Construction	Sept. 8, 1896.	Sept. 11, 1896.	April 21, 1897.



SECTION 10



WASHINGTON ST

TYPICAL CROSS SECTIONS OF THE SUBWAY SHOWING DIFFERENT STAGES IN THE PROGRESS OF THE WORK

Scale
1" = 10' 0"

Work referred to in previous Annual Report. — Openings had been made by the Engineering Department, between July 22 and August 15, 1896, for two 18-foot side-wall pockets, one half-way between Friend and Merrimac streets and the other in Friend street, and a small amount of permanent work had been constructed in them. These openings were largely of an experimental character, but the system then inaugurated has been successfully continued.

Report of
Chief
Engineer.
Section 10.

General Description of Structures. — This section includes a four-track subway in Washington street, widening out into a station with two island platforms at Haymarket square. The regular four-track portion has two spans with a row of steel posts between them. The total inside width is about 47 feet, bringing the side-walls almost to the foundation-walls of the buildings on each side of the street, as shown by cross-section on Plate 36. At the point where this cross-section is taken, the outside of the subway back-wall comes within about $2\frac{1}{2}$ feet of the foundation-walls of the buildings and is carried to a depth of about 9 feet below them. At other points the back-wall comes closer to the buildings and extends to a greater depth. At the corner of Washington and Merrimac streets it was necessary to remove piles from under the masonry foundations of buildings, and replace them by the concrete back-wall of the subway. In order to leave room for pipes under these conditions, the curved type of side-post was adopted throughout the regular four-track subway.

A 24-inch water-main was carried diagonally beneath the station structure at Union street, and the timber and concrete sewer, 5 feet high, referred to further on, likewise passes under the station. Provision was made, in the arches of the station roof, for carrying 18-inch and 6-inch gas-pipes, as well as wire conduits.

The position and extent of the section with relation to the rest of the subway can be seen on the progress map. The junction of the southerly end of the station with the four-track subway is shown by photographic view on Plate 38. A total of 924 lin. feet of side-walls was put in by day labor, under the direction of the Engineering Department, and a further length of 412 feet (including the whole of the station) was put in as part of the construction contract.

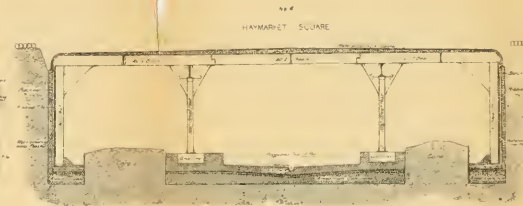
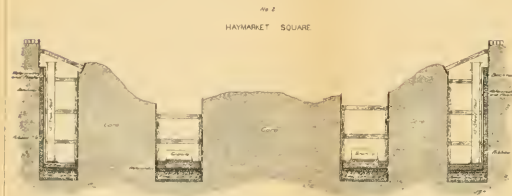
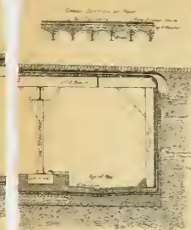
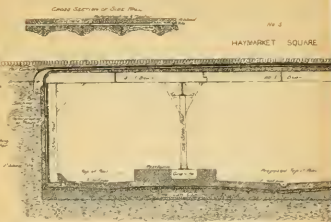
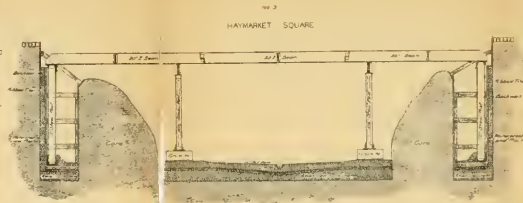
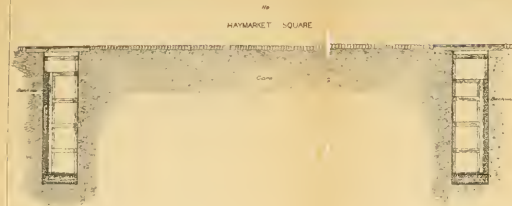
Method of doing Work in Washington Street. — Plate 36 shows different stages in the progress of this work. The method of putting in side-walls closely resembles that adopted at a later period for Section 8 and explained under that heading, but the excavation on Section 10 was done partly by a trench machine and partly by steam-hoisting derricks. The excavation for side-walls was carried to a nearly

Report of
Chief
Engineer.
Section 10.

uniform depth of 19 feet, the greater part of the trench being beneath sidewalks, and the first 10 feet in depth usually consisted of masonry area-walls. These were treated as described under Section 9. As the direct work on side-walls progressed, *i.e.*, as soon as a sufficient length of opposite side-walls had been built, construction was carried on by the contractors for the remaining portion of the work in the middle of the street as follows :

In the regular four-track portion of the work, a continuous trench, about 7 feet wide, was excavated for the central row of steel columns, this work being done entirely at night and bridged at the street level before morning. The upper and lower concrete invert were then put in along this strip and the central columns erected. Excavation by the "slice" system was then carried to a depth 5 feet below street level, to admit of placing the steel roof-beams, the street surface being bridged during this operation as described under Section 8. Brick jack-arches were turned between the I-beams as soon as these were secured in place. Over the arches was placed a layer of concrete, 3 inches above the beams at sides, and 6 inches in centre, coated successively with $\frac{1}{2}$ inch of Portland cement plaster, and $\frac{3}{4}$ inch asphalt water-proofing. The street was then paved and restored to its former condition. The lower core of earth, left in at the time of bridging the street, was next taken out by teams passing up the temporary incline into the old Boston and Maine station. The lower and upper invert of the subway were next completed, the intervening waterproof course being carefully connected with that of the side-walls by means of the "laps" left for that purpose. Longitudinal 8-inch channel pipes were laid in the upper invert, along the centre of each two-track location, and small cross-gutters join these at 9-foot intervals, leading from the rib-tile spaces in the side-walls to carry off whatever leakage may reach them.

Method of doing Work in Haymarket Square. — In the station continuous trenches were first excavated for the side-walls, concrete back-walls put in, and rib-tile work laid on. Steel side-posts were then erected, 6 feet apart, upon sections of bottom prepared for that purpose. Sections were then excavated in the central portion, to allow of the granite footing-stones for the central line of columns being set in place, and these columns were then set up at intervals corresponding with the side-wall posts. The erection of roof-steel followed, and as the I-beams were set and secured brick jack-arches were turned between them, as in the four-track portion, except that no bridging of the street for traffic was necessary in the wide space of station location. The



SECTION 10



HAYMARKET SQUARE

MARKET SQUARE

TYPICAL CROSS SECTIONS OF THE SUBWAY SHOWING DIFFERENT STAGES IN THE PROGRESS OF THE WORK

MARKET SQUARE

earth core in the station was removed, partly by large buckets swung from a heavy boom-derrick, and dumped into carts on the surface, and partly by hauling direct up the temporary incline leading into the old Boston and Maine station. Plate 37 shows the successive stages of construction, and the section is further illustrated by photographic views on Plates 35 and 38.

Report of
Chief
Engineer.
Section 10.

The roof covering of the station varies in some respects from that adopted for the four-track subway. On the top of the asphalt waterproof coating is laid a 2-inch layer of fine crushed stone, free from dust, and on this is spread a 3-inch sheet of tar concrete. It is anticipated that this arrangement will minimize the vibration caused by street traffic and tend to prevent the transmission of noise from the street to the station beneath.

Force employed. — The ordinary force employed on direct work consisted of 150 men and 15 double teams, working two 11-hour shifts per day in the general proportion of 60 day men to 90 night men. The day work was practically finished November 5, 1896. On the contract work there were also two 11-hour shifts, composed of about 80 men during the day and 50 at night, with 10 double teams all the time. The contract work was substantially completed April 21, 1897. The annexed tables contain data as to the respective amounts of work done, rate of progress, etc., on direct and contract work :

Progress on Direct Work.

ITEMS.	Amount of work done previous to Aug. 15, 1896.	Date of completing.	Amount of work during year ending Aug. 15, 1897.	Average rate of progress per week during respective working periods, year ending Aug. 15, 1897.	Total quantities in completed section (direct work).
	<i>Cubic yards.</i>	<i>1896.</i>	<i>Cubic yards.</i>	<i>Cubic yards.</i>	<i>Cubic yards.</i>
Excavation . . .	145	Nov. 1	5,245	477	5,390
Steel erection . .	5 tons	Nov. 5	173 tons	14 tons	178 tons
Concrete walls . .	56	Nov. 9	1,866	156	1,922
Plastering	45 sq. yds.	Nov. 4	1,755 sq. yds.	146 sq. yds.	1,800 sq. yds.
Waterproofing . .	73 sq. yds.	Nov. 4	3,377 sq. yds.	281 sq. yds.	3,450 sq. yds.
Rib-tiling	42 sq. yds.	Nov. 2	1,193 sq. yds.	108 sq. yds.	1,235 sq. yds.

Report of
Chief
Engineer.

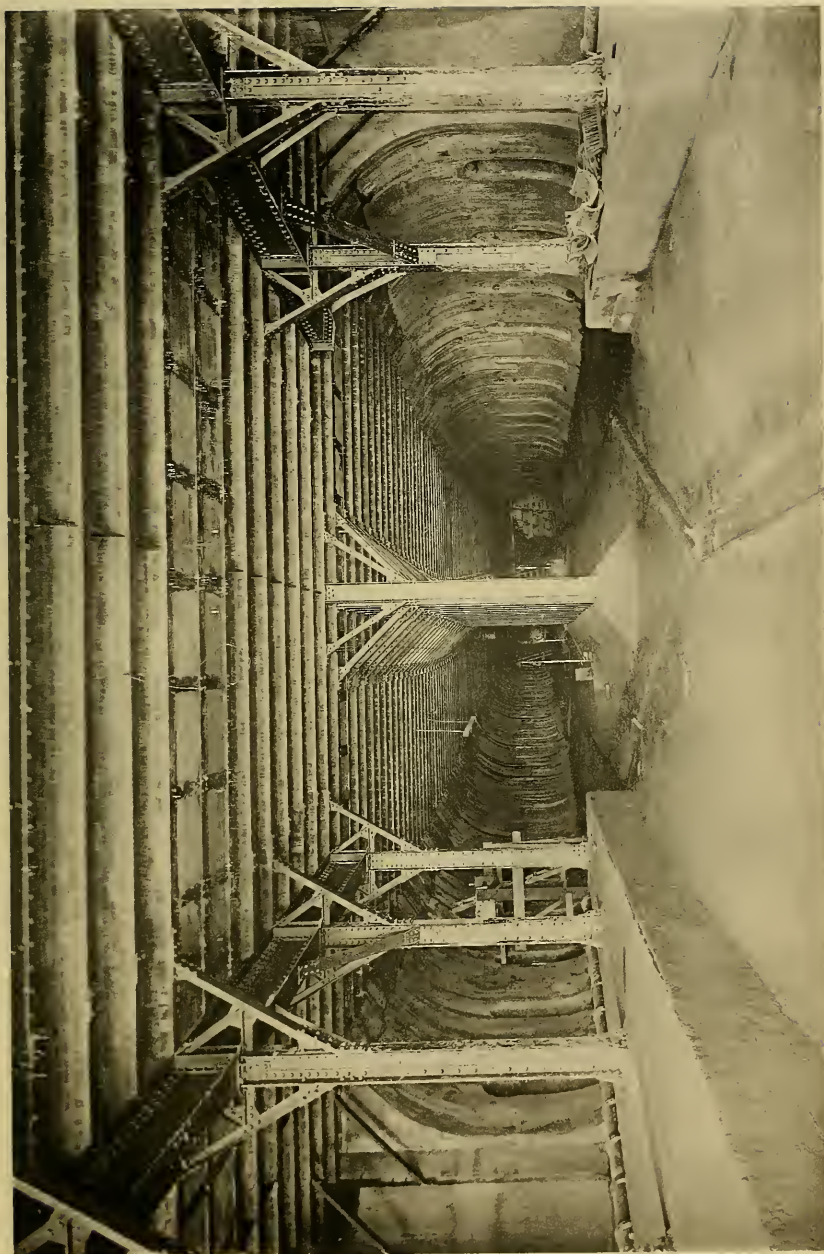
Progress on Contract Work.

Section 10.

ITEMS.	Date of beginning.	Date of completing.	Total quantities in completed section (con- tract work).	Average rate of progress per week during respective working periods.
	1896.	1897.	Cubic yards.	Cubic yards.
Excavation	Sept. 21	Mar. 24	25,126	930
Concrete invert	Sept. 29	Mar. 31	1,893	73
Granite footing-stones	Oct. 16	Mar. 6	35	1.7
Steel erection	Nov. 6	Mar. 25	646 tons	32.3 tons
Concrete walls	Oct. 2	April 10	475	18
Brick masonry	Dec. 3	April 1	511	30
Concrete in roof	Dec. 3	April 12	1,356	80
Plastering	Oct. 7	April 13	5,645 sq. yds.	182 sq. yds.
Waterproofing	Oct. 9	April 13	9,545 sq. yds.	308 sq. yds.
American concrete masonry	Oct. 20	Mar. 30	627	27
Rib-tiling	Oct. 15	April 7	662	26

Character of Excavation. — The depth of excavation, from the surface to the under side of subway invert, varied little from 18 feet throughout the section. At the northerly end of the station, owing to the presence of peat from a level of 12 feet below the street surface, it was necessary to take out 3 feet additional. Stiff yellow clay was found throughout, except at the southwesterly corner of Hanover and Washington streets, where sand and gravel were met with. The site of the station, above the peat, was nearly all filled ground. Remnants of the old Middlesex canal structure were encountered here, also two wooden box sewers, one disused, the other in service. A new timber and concrete sewer, 5 feet high inside, was constructed by direct work to take the place of the latter. The small volume of ground water found was pumped out with a steam-pump located in the station portion of the work, towards which all grades tend. A length of 150 feet of under-drain was laid to facilitate the flow of water to the pump-well.

Accidents. — Two deaths were caused by accidents to the contractors' workmen. In one case an Italian laborer, Giuseppe Mastroria, was killed on December 19, 1896, by the fall of the masonry of an old catch-basin in the earth core in Washington street, near Haymarket square. During the night of January 24, 1897, Fred McClinchey, a carpenter, while setting centres for jack-arches in Washington street, between Hanover street and Haymarket square, fell through the roof to the subway beneath, and died almost instantly.



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BOSTON TRANSIT COMMISSION

SECTION 10. PART OF HAYMARKET-SQUARE STATION, LOOKING SOUTHERLY. FOUR-TRACK SUBWAY UNDER NEW WASHINGTON STREET. CURVED SIDEWALLS AND NICHES. APRIL 2, 1897.

REPORT OF GRADING OPERATIONS ON BOSTON COMMON
 DURING THE YEAR ENDING AUGUST 15, 1897. (DIRECT
 WORK.)

Report of
 Chief
 Engineer.
 Common.

As stated in last year's report, it was decided in 1895 to dispose of as much as possible of the earth excavated in the Boylston and Tremont street malls upon other parts of the Public Garden and Common. Sixty-seven thousand cubic yards of surplus earth had thus been disposed of at the date of that report, and the work, so far as it affected the Public Garden, was completed at that time. On the Common, the work of grading, etc., was continued until December 19, 1896, when it was stopped on account of cold weather. It was resumed on April 8, 1897, and continued until nearly all of the affected area was seeded down, the exceptions consisting of small sections immediately adjoining the Boylston and Tremont street malls. The completed areas were turned over to the Superintendent of Public Grounds on June 1, 1897. All walks, with the exception of a few which seemed unnecessary under the changed conditions, were restored to their former condition, the foundations being improved in the process. The portion of the Common adjoining Beacon street, originally a grass surface, has not been seeded down after the raising of the grade, it having been decided to reserve it for a ball-ground.

Care has been exercised to preserve the trees which were interfered with, and practically all of them are in good condition, though at one time several in the Public Garden seemed likely to die.

The operations were carried on by direct work, *i.e.*, under the direct control of the Engineering Department. The average number of workmen employed during the progress of the work was 25, working during the daytime only. About 85,000 cubic yards of filling have been disposed of on the Public Garden and Common, of which 18,000 cubic yards were distributed (wholly on the Common) during the year under review. A marked improvement has been effected in the appearance and general condition of the westerly part of the Common.

REPORT ON CHANGES IN PIPES AND SEWERS FOR YEAR
 ENDING AUGUST 15, 1897.

Pipe and
 Sewer
 Changes.

City Assistants. — Leonard H. Davis, Assistant Engineer; Laurence B. Manley, Assistant; E. St. J. Maunsell, Transitman; Louis D. Tracy, Rodman from October 27, 1896, to April 25, 1897.

The work of moving the pipes, sewers, and conduits that

Report of
Chief
Engineer.

Pipe and
Sewer
Changes.

have interfered with building the subway has been done in part by contract and in part directly by the Commission under the direction of the Engineering Department.

Since the date of the last annual report the Edison Electric Illuminating Company, the New England Telephone & Telegraph Company, and the Boston Electric Light Company have declined to make any further changes of their conduits ordered by the Commission.

The following contractors, recommended by their respective companies, have been employed for making changes in pipes and conduits :

Alfred N. Farrington, contractor for relocations of pipes of the Bay State Gas and Boston Gas Light Companies.

John S. Potter, contractor for relocations of conduits of The Edison Electric Illuminating Company of Boston.

George H. Dresser, contractor for relocations of conduits of The New England Telephone & Telegraph Company of Massachusetts.

The National Conduit Manufacturing Company of New York, for relocation of conduit of the Boston Electric Light Company.

Descriptions of the sewers built as part of the subway sections are given in the reports on those sections. The lengths and sizes of the other sewers and of pipes and conduits relocated during the year just ended are given below :

Sewers.

SIZE.	Linear feet removed. ¹	Linear feet laid.
5 feet × 4 feet to 2.5 feet, wood and concrete (siphon)	108.0	108.0
4 feet × 4 feet, wood	17.0	17.0
30-inch by 33-inch, wood	40.0	55.0
30-inch cast-iron pipe (siphon)	180.3	180.3
24-inch × 27-inch, brick	134.0	
20-inch × 30-inch, brick	142.0	
20-inch × 24-inch, brick	25.5	
18-inch × 12-inch, wood	86.5	
18-inch pipe	391.6	391.6
15-inch pipe	42.0	
15-inch square, wood, brick, and stone	113.0	
12-inch pipe	169.0	186.2
8-inch pipe	14.4	14.4
3 manholes removed, 8 manholes built. 1 manhole partially rebuilt.		
Total	879.0	952.5

¹In most cases removed from the ground; in some cases merely abandoned.

*Water-Pipes.*Report of
Chief
Engineer.

SIZE.	Linear feet removed. ¹	Linear feet laid.	Pipe and Sewer Changes.
30-inch	56.4	56.4	
24-inch	87.0	87.0	
20-inch	4.0	4.0	
16-inch	222.6	178.1	
12-inch	1,643.6	2,175.1	
8-inch	517.8	2,186.0	
6-inch	775.1	150.0	
4-inch	364.5	16.1	
Gates removed, one 24-inch, three 12-inch, one 8-inch, eight 6-inch, one 4-inch.			
Gates set, one 24-inch, one 16-inch, nine 12-inch, nine 8-inch, five 6-inch.			
Hydrants removed, 7.			
Hydrants set, 8.			
Total	3,667.0	4,852.7	

¹ In most cases removed from the ground; in some cases merely abandoned.*Gas-Pipes.*

SIZE.	Linear feet removed.	Linear feet laid.
<i>Bay State Gas and Boston Gas Light Companies.</i>		
24-inch	145.0	
20-inch	16.0	
18-inch	1,778.0	537.5
12-inch	93.0	106.8
8-inch	54.0	140.3
6-inch	3,732.2	2,255.0
4-inch	40.0	40.3
3-inch		246.6
Gates removed, one 20-inch, two 18-inch, one 12-inch, thirteen 6-inch.		
Gates set, one 18-inch, one 12-inch, two 8-inch, nine 6-inch, one 4-inch.		
<i>Brookline Gas Light Company.</i>		
12-inch	516.0	468.0
6-inch	40.0	45.0
4-inch	67.0	61.8
Gates removed, one 12-inch, one 4-inch.		
Gates set, one 12-inch, one 4-inch.		
Total	6,481.2	3,911.3

Report of
Chief
Engineer.

Pipe and
Sewer
Changes.

Electric Conduits.

SIZE.	Linear feet removed.	Linear feet laid.
<i>Edison Electric Illuminating Company.</i>		
3½-inch	74.5	74.5
3-inch	492.6	519.1
2½-inch	284.3	292.8
2-inch	1,256.3	1,298.6
Junction boxes removed, 6.		
Junction boxes set, 6.		
Total	2,107.7	2,185.0
<i>Boston Electric Light Company.</i>		
3-inch duct	1,160.0	1,096.0
<i>New England Telephone and Telegraph Company.</i>		
3-inch duct	15,138.7	13,178.2
Manholes removed, 10.		
Manholes built, 20.		
<i>Western Union Telegraph Company.</i>		
3-inch duct	1,725.0	1,759.4
Manholes removed, 2.		
Manholes built, 5.		

The work has been done largely at night and on Sundays in order to minimize the inconvenience to street traffic, and to avoid unnecessary interference with the services of pipes and conduits. Work on sewer changes has been carried on both by day and by night, a considerable portion of it by tunneling, notwithstanding the increase in cost. The practice has been to relocate pipes wherever practicable in advance of the subway work. In general, where this method has been impracticable, obstructing pipes have been either temporarily relocated or cut out altogether, and left out until the subway was sufficiently completed to admit of relaying them.

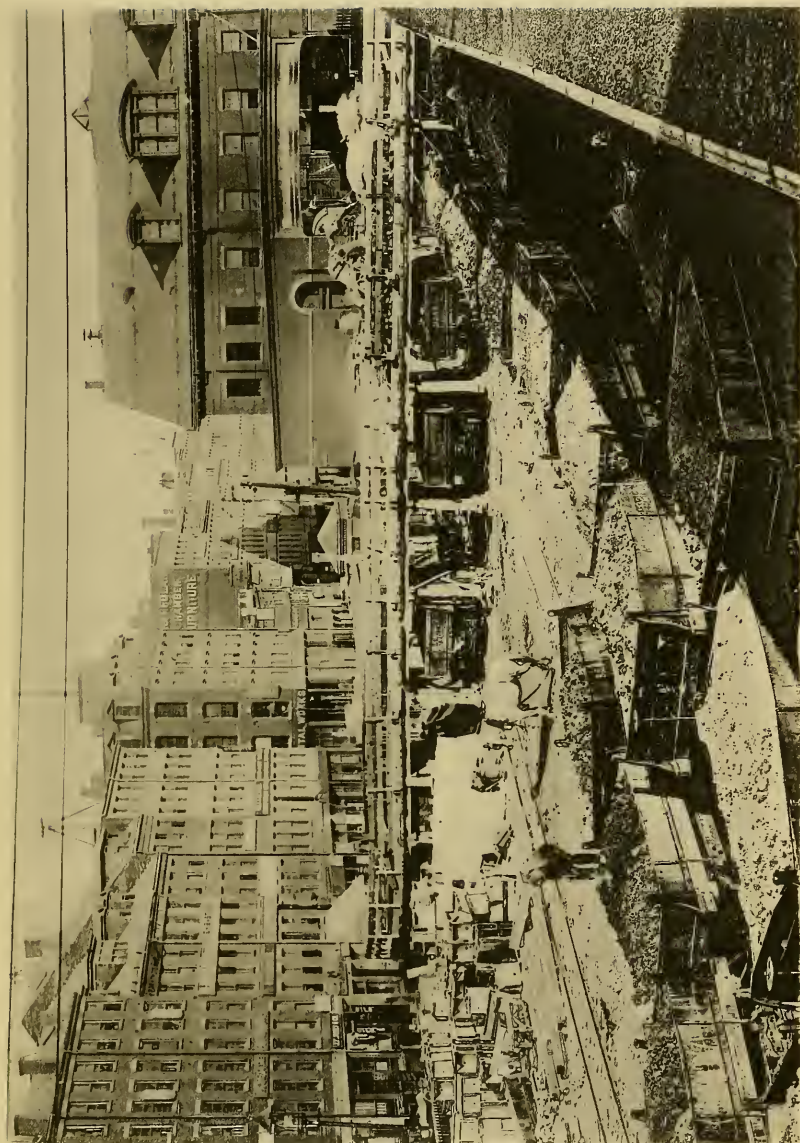
For a considerable length of the subway sections between Scollay square and Haymarket square, space for pipe and conduits has been provided by curving the upper part of the side-walls, as explained under the various sections thus affected. (See Plates 31 and 33.) Where permanent pipe-crossings over the completed subway structure require it, special passages between the roof-beams are provided, and at most such places additional passages have been made for possible future use. At Haymarket square the nearness of the subway roof to the surface of the street rendered it impracticable to carry large pipes overhead in the ordinary way. The crossing of an 18-inch gas-pipe was therefore effected by



BOSTON TRANSIT COMMISSION

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TUNNEL FOR SEWER SIPHON UNDER SECTION 10, HAYMARKET-SQUARE STATION, LOOKING
WESTERLY. NOVEMBER 16, 1896.



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BOSTON TRANSIT COMMISSION

TEMPORARY BRIDGE FOR LOADING CARS WITH EARTH FROM SUBWAY. FREIGHT YARD OF OLD BOSTON & MAINE STATION, LOOKING SOUTHERLY. MAY 6, 1897.

making the pipe of riveted steel instead of cast-iron. For the same reason, a 24-inch water-pipe in Haymarket square was carried beneath the subway, all of the pipe below the ordinary depth in the ground being surrounded with concrete.

Report of
Chief
Engineer.

Pipe and
Sewer
Changes.

In some streets larger sizes of water-pipes than those removed have been laid at the request of the Water Department, which bears the additional expense due to the increase in size. In like manner the Sewer Department, anticipating the erection of buildings with deeper basements and a consequent demand for lower drainage, has taken advantage of the necessity of building new sewers to obtain deeper ones in Tremont row, Hanover street, Cornhill, and a part of Washington street. It has also been necessary in certain instances to divert the drainage from one district into another. The location of the subway in Washington street, and the entire surrounding of the district bounded by Cornhill, Court street, Hanover street, and Washington street by subways, rendered necessary the building of a siphon under and across the subway in the latter street, at Hanover street. This siphon is about 90 feet long and consists of two 30-inch cast-iron pipes laid side by side in concrete, with their tops about 3 feet below the subway rail elevation. At each end is a large manhole provided with a separate chamber for each 30-inch pipe, and with stop-planks, the purpose of which is to divert the flow into one pipe while cleaning the other out. The siphon was built by tunnel, and on account of the proximity of a part of it to the building at the corner of Friend and Washington streets, the top and sides of the tunnel near the foundations were grouted so as to fill any possible void spaces. A 36-inch bull's-eye was built in the easterly manhole to provide for a possible low-level sewer in Hanover street to the proposed Canal-street relief sewer. This low-level sewer, if built, would reduce the up leg of the siphon from its present height of about 10 feet to about 2 feet and 7 inches. A temporary siphon about 108 feet long was also built across Haymarket square beneath the subway station at that place. This was put in to replace a wood sewer 4 feet square which crossed the line of the subway, and which, in time of heavy rains, acted as a partial relief to the Canal-street sewer, and therefore needed to be maintained until the proposed Canal-street relief sewer could be built. This siphon was also built in a tunnel, and its shape was made to conform to that of the tunnel, the interior dimensions of the siphon being — height, 5 feet; width, at bottom, 4 feet, at top, $2\frac{1}{2}$ feet. It consisted of a wooden framework and lining and a concrete and grout filling between the woodwork of the siphon and the tunnel lagging. (See Plate 39.)

Report of
Chief
Engineer.

Pipe and
Sewer
Changes.

At the present date about 91 per cent. of pipe changes due to subway construction has been completed. The approximate cost of these changes from the beginning of subway work to August 15, 1897 (exclusive of cost of sewers built as a part of day or contract work on regular subway sections), is as follows :

Sewers	\$30,900
Water-pipes	62,880
Gas-pipes	28,170
Electric conduits	13,310
Total	<u>\$135,260</u>

DISPOSAL OF RAIN WATER ENTERING THE INCLINES, ETC.

The rain water which enters the subway from the open inclines is, together with the small amount of water which percolates through the walls, lifted from 12 to 18 feet by automatic electric pumps to the city sewers. From measurements that have been taken it appears probable that the total work (theoretical) of pumping the leakage in the entire subway will be less than one-third of a horse-power. Substantially all of this leakage will come through the small drains in the invert leading from hollows left in the side-walls. Very little dampness except from infrequent atmospheric condensation is to be found on the interior surface of the subway.

SUBWAY IN BUDAPEST, HUNGARY.

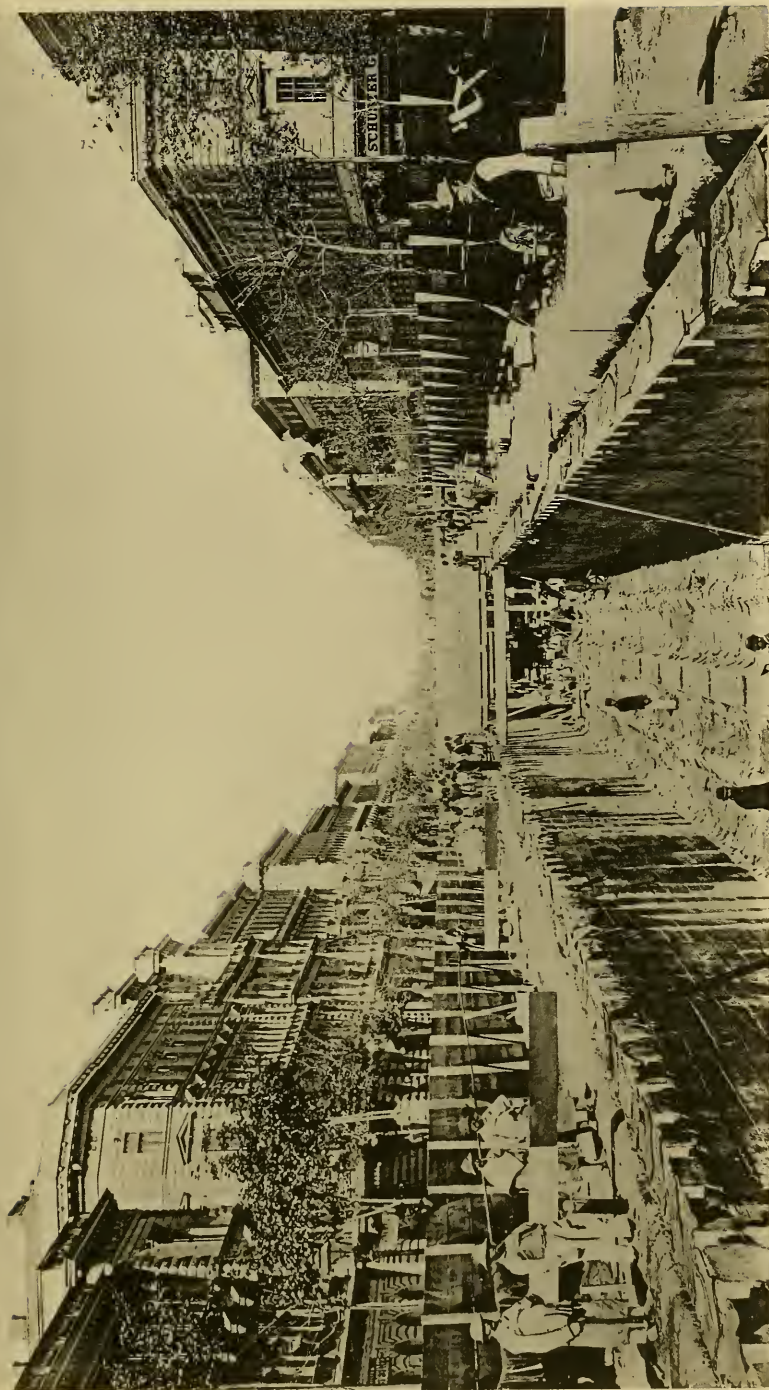
Some allusion was made in the second annual report to the subway which lies for the greater part of its length under one of the most beautiful streets in Budapest, Hungary. This subway bears some resemblance in the manner of construction, especially of the roof, to a portion of the Boston subway. By direction of the Commission five plates illustrating the Budapest subway are given in this report. Plates 41 and 42 show construction methods, Plates 43 and 44 show surface stations, and Plate 45 shows a portal. The relative sizes of this subway and the two-track portion of the Boston subway are indicated on Plate 45.

COST OF THE SUBWAY.

The statement in regard to cost made in the last annual report can be substantially repeated in this. Nothing has been discovered so far to indicate that the cost of the subway, seven-eighths of which is now done, will exceed the Engineer's estimate made before the beginning of the work early in 1895.

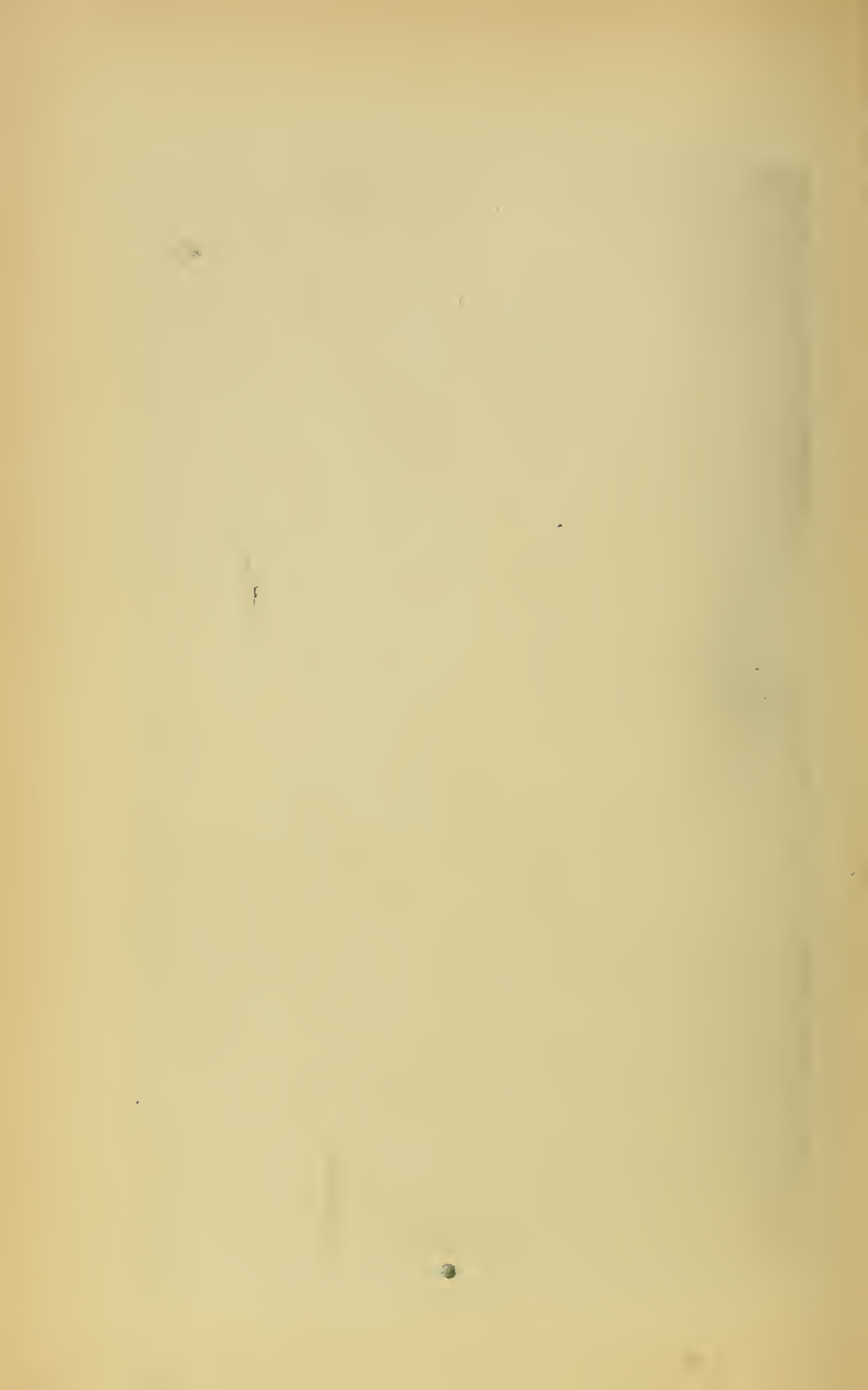
Respectfully submitted,

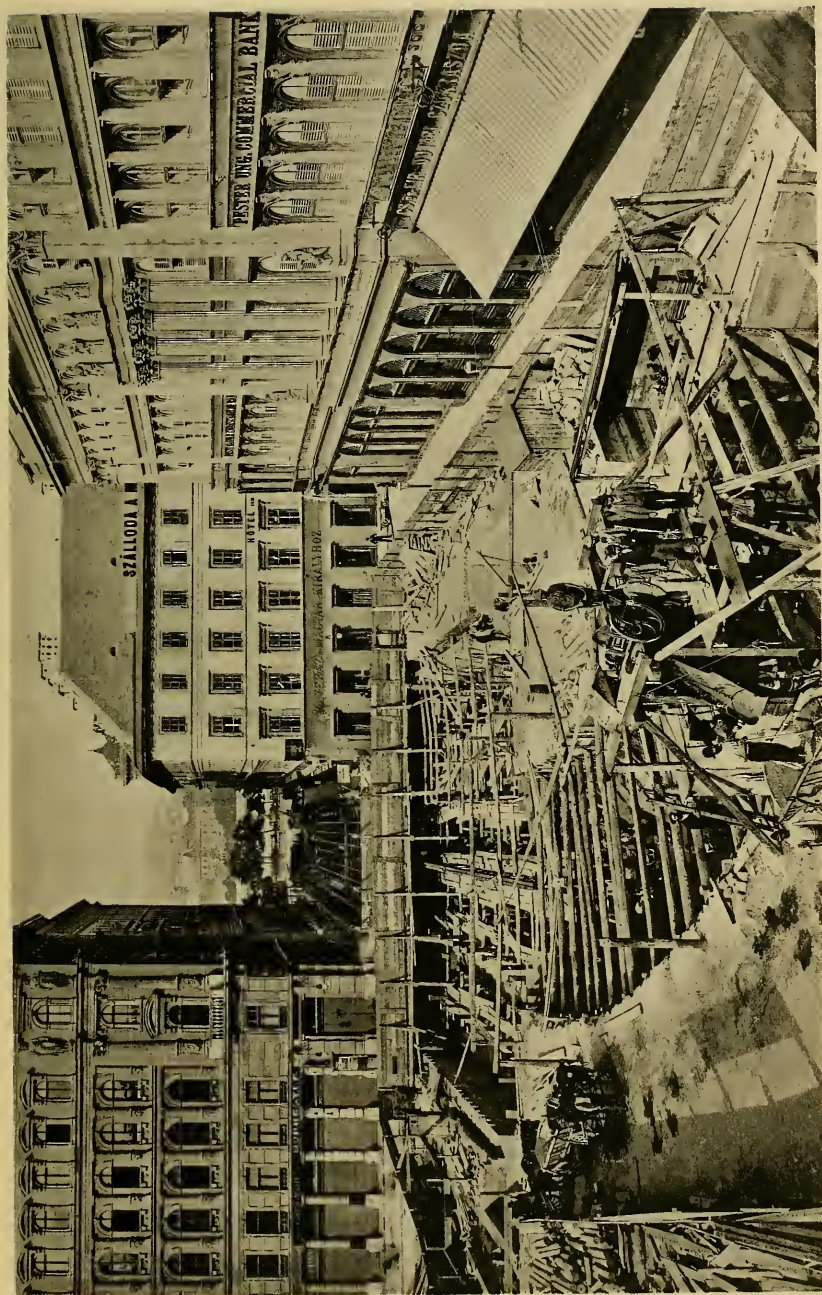
HOWARD A. CARSON,
Chief Engineer.



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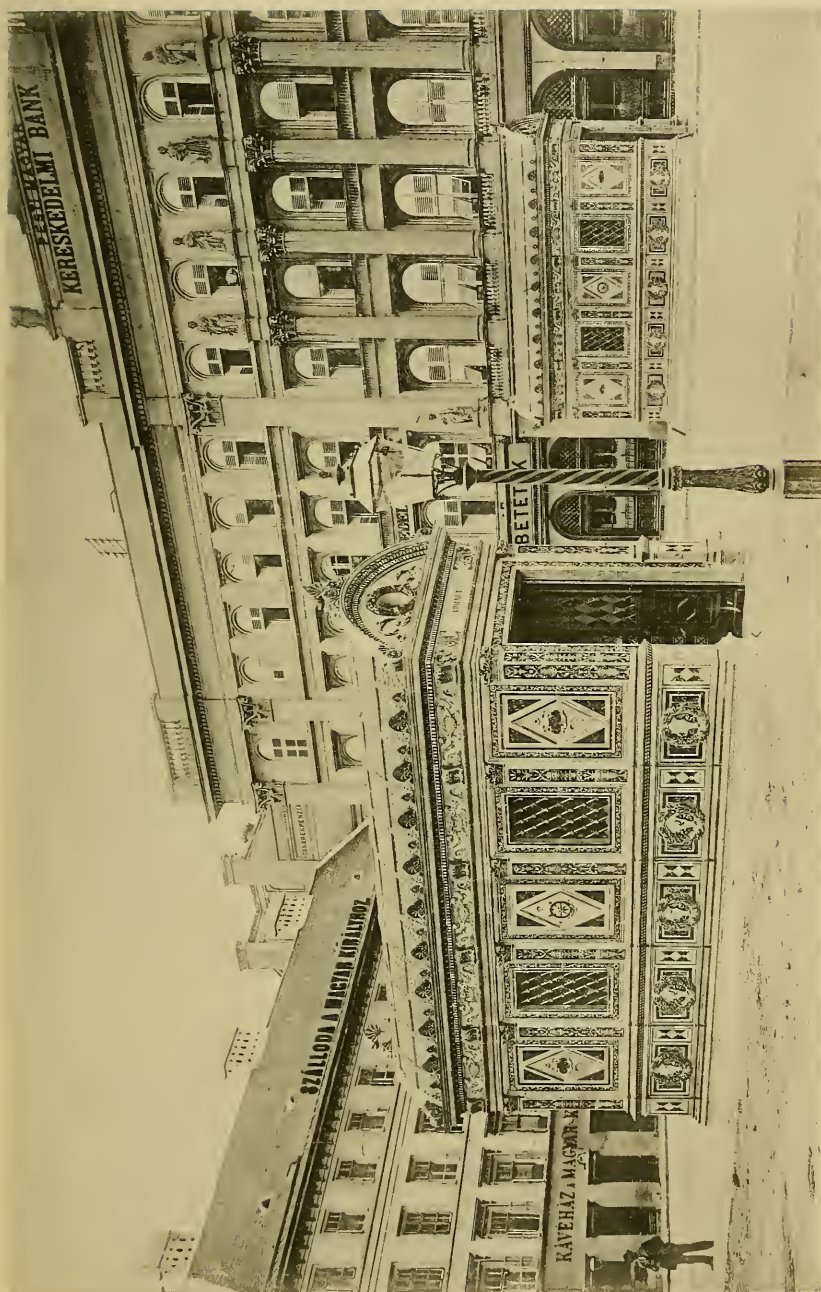
BUDAPEST SUBWAY IN ANDRÁSSYSTRASSE. NEARLY READY FOR THE ROOF.





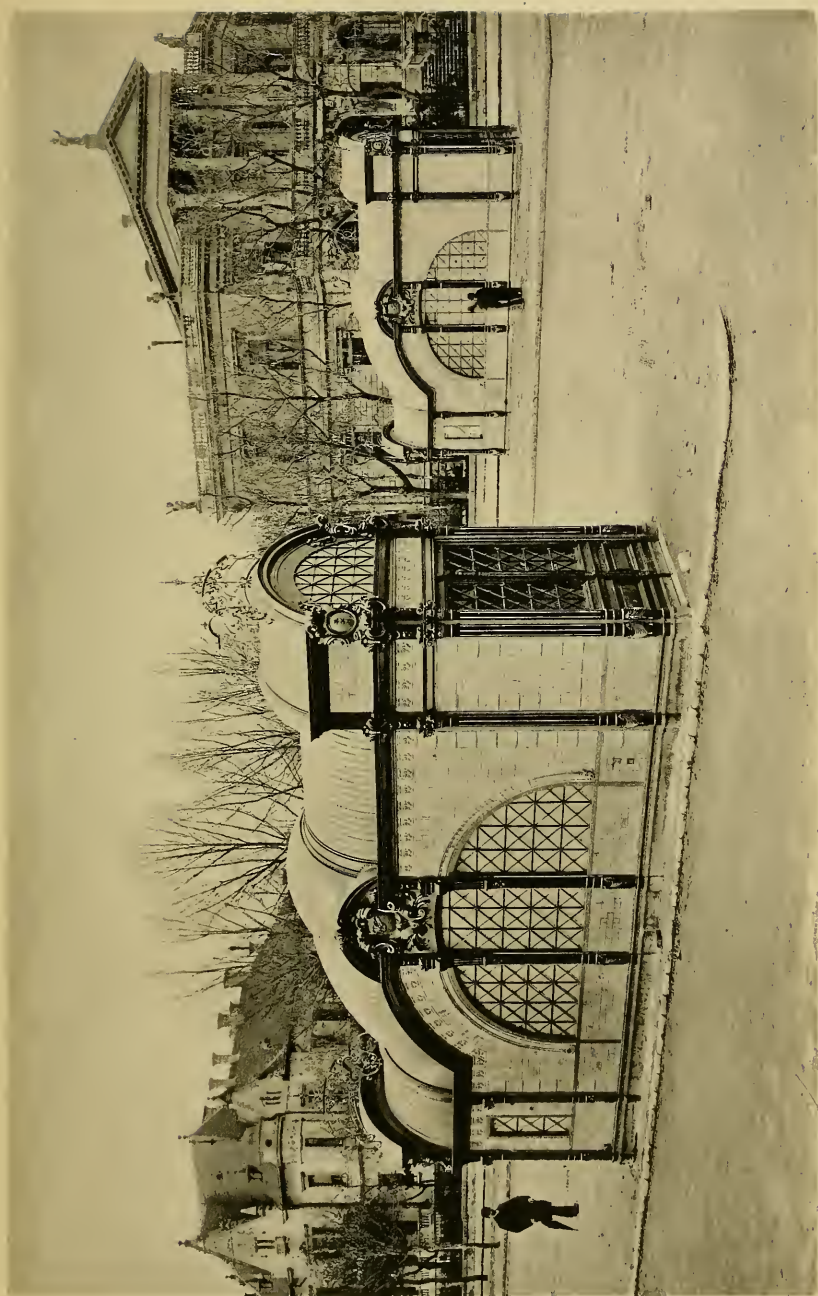
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BUDAPEST STATION AND SUBWAY IN GISELLAPLATZ. NEARLY READY FOR THE ROOF.



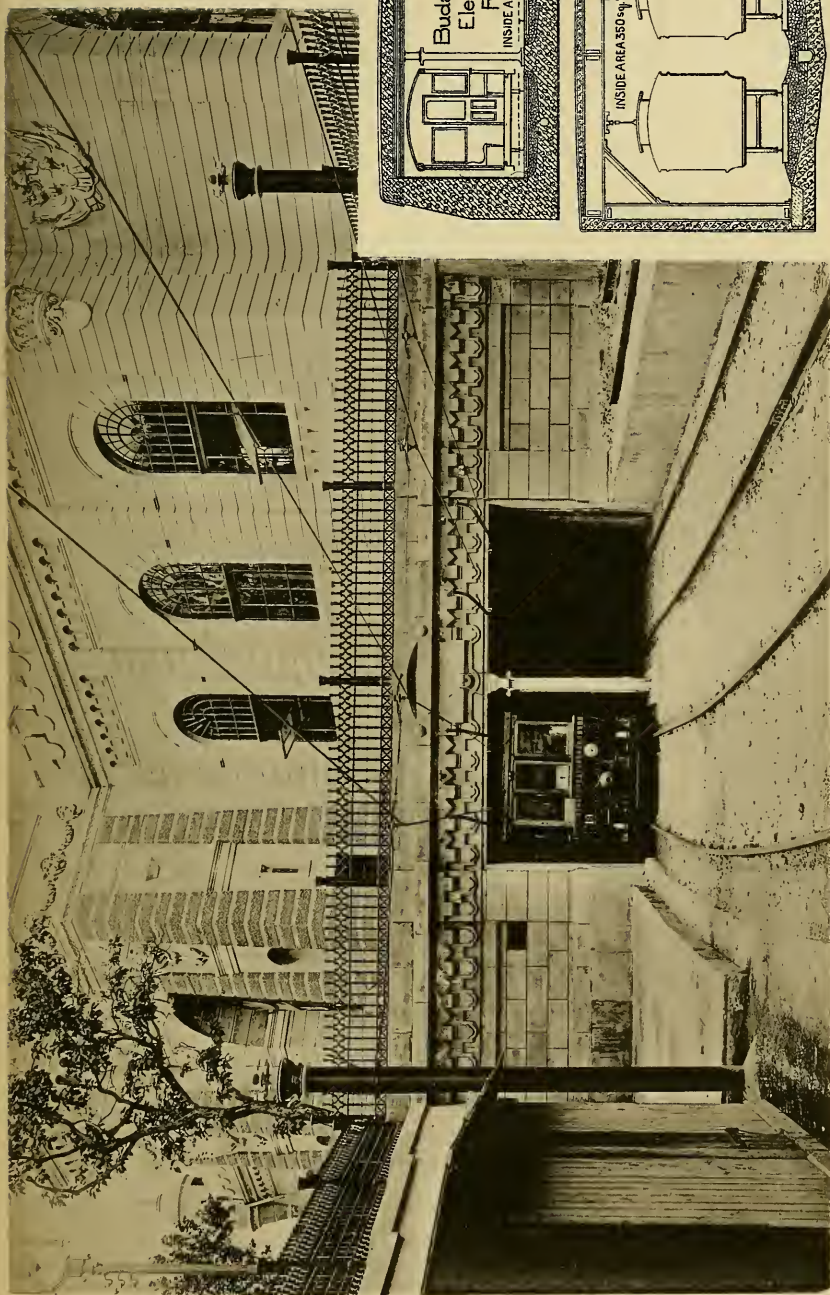
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BUDAPEST SUBWAY. STAIRWAY COVERINGS TO GISELLAPLATZ STATION.



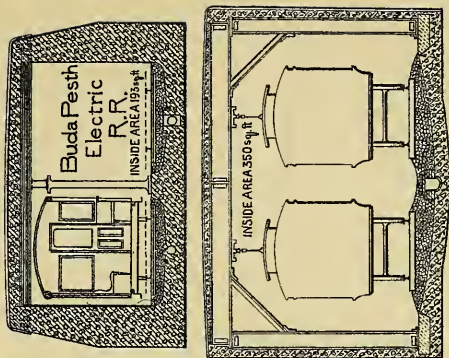
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BUDAPEST SUBWAY. STAIRWAY COVERINGS TO ARENASTRASSE STATION.



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BUDAPEST SUBWAY. PORTAL IN THE PARK (STADTWÄLDCHEN).



RELATIVE SIZES OF CROSS-SECTION OF
BUDAPEST SUBWAY AND TWO-TRACK
PORTION OF BOSTON SUBWAY.

REPORT OF THE CHIEF ENGINEER FOR
CHARLESTOWN BRIDGE.

50 CITY HALL, August 16, 1897.

GEORGE G. CROCKER, CHARLES H. DALTON, THOMAS J.
GARGAN, GEORGE F. SWAIN, HORACE G. ALLEN,
Boston Transit Commissioners:

GENTLEMEN: The work of the engineering force of the Charlestown bridge during the year ending August 14, 1897, consisted of (1) the making of plans and specifications for the Boston and Charlestown abutments and eight spans of the superstructure, detailed designs for the northern part of the Charlestown approach, and plans for a fender guard at one of the draw channels; (2) the making of studies for the northern and southern approaches, including the bridges across Water street and the Fitchburg Railroad and the proposed alterations in the grade of Causeway street and the connecting thoroughfares, and other studies chiefly connected with the taking of land for the approaches or the appraisal of damages; and (3) the supervision of construction under the contract for the ten masonry piers and other contracts made in the course of the year.

With the details of the various studies made and abandoned with reference to the grades of the approaches, it is not necessary to encumber the report. It may be said, however, that these studies have not developed any satisfactory substitute for the arrangement of grades announced in last year's report; namely, a three per cent. gradient for the Boston approach and the northern end of the Charlestown approach, and a gradient of eight-tenths of one per cent. between the Fitchburg Railroad and the drawspan.

The designs for the abutments resemble those for the masonry piers. A retaining-wall of granite masonry is to rest upon a foundation of Portland cement concrete. At the Charlestown abutment, where very hard bottom is reached at a level from four to seven feet below low water, no bearing piles are required, but at the Boston end, where the borings show deep beds of silt, the concrete foundation is to be supported upon piles driven to hard bottom, and to diminish the thrust of the filling behind the abutment it is to be sustained by a timber platform at grade 8, resting on piles driven to hard bottom. The contract for the abutments was awarded to Messrs. Perkins & White.

At the northern end of the Charlestown approach the retaining-wall supporting the inclined roadway is to be of quarry-faced granite resting on a concrete foundation. The courses are to be of uniform thickness, and the face stones are to be alternate headers and stretchers. Near the corner of Water street and Warren avenue there will be a stone staircase consisting of three flights of steps with intermediate landings. The abutment for the Water-street bridge is to be of the same class of masonry as the retaining-wall.

Bids were received on April 28 for the steel superstructure of eight of the ten water spans of the bridge. The contract for this work was made with the lowest bidder, the A. & P. Roberts Co., of Philadelphia, Pa.

Messrs. Perkins & White, the contractors for the ten masonry piers, began the dredging for the pier foundations eleven days before the beginning of the year covered by this report. Though they carried on the work throughout the year, except for a few days when the weather was very bad, the contract is not finished at the date of this report, the stone-work at piers 3 and 5 and the concrete foundation at pier 5 not having yet been begun, and the stone-work at all the piers and the foundation of pier 3 being still incomplete.

Table I. shows the order in which the piers and abutments were built and the date of beginning and finishing each class of work on each pier.

TABLE No. I.

PROGRESS SHEET TO AUG. 14, 1897.

THIRD ANNUAL REPORT.

69

	Boston Abut.	Pier 1.	Pier 2.	Pier 3.	Pier 4.	Pier 5.	Pier 6.	Pier 7.	Pier 8.	Pier 9.	Pier 10.	Chas'n Abut.
Excavation	May 12 begun finished	6 Oct. 17 Nov.	5 Sept. 21 "	2 Sept. 4 "	Aug. 24 27 "	Oct. 6 31 "	Aug. 24 24 "	Aug. 20 22 "	Aug. 4 11 "	Aug. 7 28 "	Aug. 11 25 "	May 13, not finished.
Driving low piles	begun finished	" 19 Jan.	" 7 Feb.	" 5 Feb.	{ Sept. 15 } { Feb. 27 } Apr. 21	" 29 "	" 14 "	Sept. 2 "	" 19 "	" 27 "	"	"
Low piles cut off	begun finished	Dec. 4 5 "	" 12 13 Mar.	" 24 1 "	" 24 26 "	July 1 3 "	Oct. 1 2 "	Sept. 26 1 "	Sept. 26 1 "	" 27 "	"	"
Driving high piles	begun finished	" 8 12 "	" 14 25 "	" 4 25 "	" 27 May 6	" 6 17 "	" 15 17 "	" 5 10 Oct.	" 28 2 "	"	"	"
Coffer-dams	begun finished	" 19 31 Feb.	" 26 18 Apr.	" 10 5 "	" 14 June 1	" 28 Nov.	" 9 19 Nov.	" 26 13 "	" 9 Sept. 30 Oct.	Sept. 16 8 "	Sept. 4 14 "	July 20
High piles cut off	begun finished	" 14 Mar.	" 3 4 "	" 11 14 "	May 7 8 "	July 19 21 "	Dec. 14 18 "	" 30 Nov. 2 "	Nov. 10 12 "	"	"	"
Concrete laid under water	begun finished	Feb. 11 13 Mar.	Feb. 16 9 May	" 7 17 "	June 4 29 "	" Feb. 9	" 10 Nov. 9 Dec.	" 19 8 "	" 2 Oct. 16 "	Oct. 15 23 Oct.	Sept. 21 3 "	"
Started to pump out	"	May 10	May 19	"	July 8	"	Mar. 8	Jan. 2	Jan. 12	" 28 Sept.	26 "	"
Set anchor bolts	begun finished	" 10 12 June	" 27 2 "	"	" 12 14 "	"	" 16 Apr. 17 "	" 16 17 "	" 29 Nov. 30 "	Nov. 7 7 "	Oct. 1 1 "	"
Concrete top layer	begun finished	" 14 18 "	" 15 16 "	"	" 15 19 "	"	" 22 Apr. 3	" 19 Feb. 21 "	" 1 20 "	" 9 9 "	" 6 7 "	"
Stone masonry	begun finished	July 15	" 16	"	" 17	"	Mar. 23	" 20	" 5 Dec.	Dec. 15	" 16	"
Channels filled	"	"	"	"	"	"	"	"	"	"	Jan. 2 Oct. 27	"

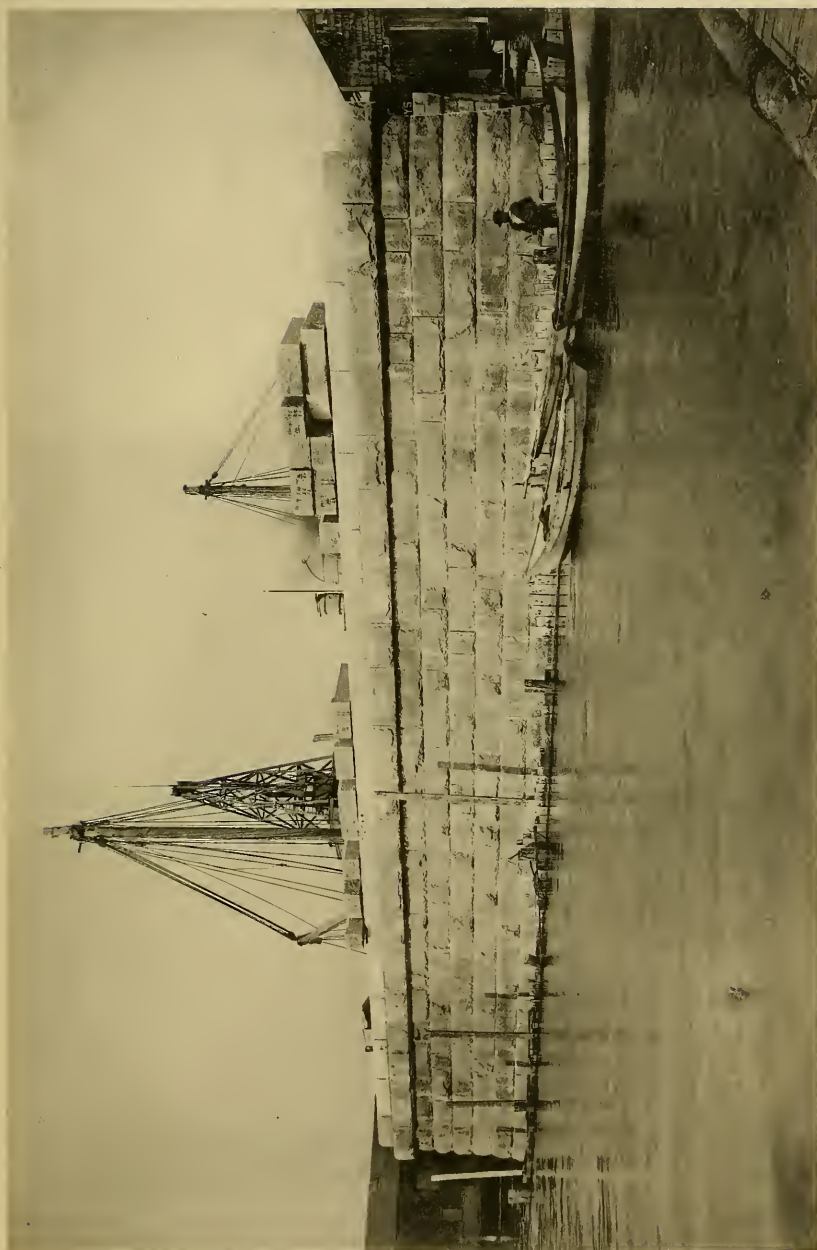
* Redredged about Jan. 3.

† 1896.

Jan., Feb., Mar., Apr., May, June, July, and Aug. 1 to 14 unless otherwise marked are 1897.

As had been indicated by the borings, extremely hard bottom was found at the sites of pier 9 and pier 10, at about the depth proposed for the bottom of the concrete. Consequently no bearing piles were required at these two piers. The hard material was found at the west end of these piers a little deeper than the bottom of the dredging called for in the contract, but at the east end it was not quite so deep. The contractor therefore dredged down to hard bottom at the west end, and was allowed at the east end to leave the bottom a little higher than the contract called for. At the other piers the dredging proceeded rapidly, and about the first of November the excavations for all the pier foundations had been finished; but in the winter it was found that a body of mud had slid into the excavation for pier 2, and before the piles were driven this mud was dredged out again.

Pile-driving began in pier 8 on August 19. The contract required alternate ranges of bearing piles to be cut off at different grades, the first, third, and fifth ranges, etc., to be cut off about 18 inches above the bottom, while the second, fourth, sixth, etc., were to be cut off about ten feet below low water. The latter, or high-grade piles, were not to be cut off until a layer of concrete six feet deep had been laid in the bottom of the foundation. The work therefore proceeded in the following order: The excavation having been dredged to the depth required by the contract, the low-grade piles were driven, and then cut off at the proper grade by a circular saw. Then the high-grade piles were driven, and were allowed to stand while a coffer-dam of sheet piling was constructed about them to serve as a mould for the concrete foundation. Concrete was deposited under water within this coffer-dam by the method described later, and when a bed of concrete six feet or more in depth had been deposited, the high-grade piles were sawed off ten feet below low water. The concrete-laying was then continued under water until the concrete reached a level a little more than one foot below the grade fixed by the contract for the bottom of the stonework; that is, in all the piers except 1, 9, and 10, 4 feet 9 inches below city base, or 5.39 feet below mean low water. The contract required that the top foot of the concrete foundation, the part immediately under the stone masonry, should be laid when the coffer-dam was free from water. The coffer-dams therefore were pumped out, the top layer of concrete laid by hand to an even grade, and the stone masonry, with its concrete backing, laid on top of it. When the masonry piers are finished, the sheet piling is to be sawed off a few inches above the top of the concrete foundation.



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This general programme was followed in piers 8, 7, 6, 1, and 2, with no important departures from the construction contemplated in the contract. At pier 3, however, owing to the difficulty of driving the piles through a layer or crust of hard material, many of them were slanted over so that the piles in one range interlocked with those in another. In this condition of things it would have been practically impossible to lay the concrete, for the crossed piles would have interfered with the movements of the chute or tube through which the concrete was deposited. The contractor was therefore ordered to cut off the high piles at a grade a few feet above the level at which the low-grade piles had been cut off, and this plan was also followed in pier 4 and pier 5.

At piers 8, 7, and 6 the piles were driven easily through gravel and clay, to a depth of from five to fourteen feet, at which depth they encountered material sufficiently firm to support the load to which they are to be subjected. At pier 1 the piles had to be driven through a bed of rather soft silt, and then through a deep bed of firmer material, before sufficient resistance was developed to sustain the load safely. At pier 4, a few feet below the bottom of the dredged excavation, was found a thin crust or layer of very hard material underlaid by a deep bed of rather soft clay. Here it was necessary to drive the piles through the crust and then through the clay till a harder stratum was reached. Driving the low-grade piles so consolidated the crust that in some parts of the foundation it was not possible to drive the high-grade piles through it.

The formation at pier 3 was similar to that at pier 4, but the crust was thicker and the underlying clay was neither so soft nor so deep. Test piles driven at this pier and at pier 2, when pulled up, were found to be crushed and broken at the lower end, owing to the hardness of the crust. The contractor was therefore directed to protect the lower end of all piles driven in these two piers with iron shoes furnished to him by the Commission. The shoes consisted of a conical iron casting moulded about a shank of wrought-iron. The shank was driven into an auger-hole bored in the axis of the pile, the foot of the pile having been sawed off square to receive the flat top of the conical casting. Test piles provided with shoes were driven deeply into hard material, and when pulled up were found to be unbroken, with the shoe still attached.

At both pier 3 and pier 4 the crust would have been, in most places, sufficiently hard and strong to bear the weight of the individual piles with their load, but it was so thin and the underlying clay so soft and so deep that it was

thought that the crust might be broken and the clay pushed aside by the weight of the pier as a whole. Consequently, wherever it was practicable, the piles were driven through the crust and through the clay into the firmer material below. At pier 2, however, the crust was so hard and thick and the layer of clay so thin and so firm that no piles were driven through the hard material. All the piles at pier 2 were shod.

At pier 5 there was no hard crust. Above the soft clay was a layer of comparatively loose stony gravel, a great part of which was removed in the dredging. In this pier the piles were driven through the soft clay, and into the somewhat harder material underneath. Shoes were not required.

The bearing piles in piers 1, 6, 7, and 8 were of spruce; at piers 2 and 3, where longer piles were required, Norway pine was used, and at piers 4 and 5 both spruce and Norway pine.

A record was kept of the length of each pile, the depth below city base to which it was driven, the penetration to each five blows of the pile-driver, and the fall and weight of the hammer used. In all the piers the driving of the low-grade piles caused the bottom of the excavation to rise a little, and the driving of the high-grade piles caused a still further rise of the bottom, so that the bottom of the concrete was in some places somewhat higher than the grade to which the dredging had been carried.

Work was begun June 1 on the southerly fender guard at the main draw channel, it being necessary to partially build this fender guard before beginning the construction of pier 5.

The sheet piling used for the coffer-dams at the piers was the Wakefield triple lap sheet piling, composed of three layers of two-inch spruce plank bolted and nailed together. For the coffer-dam at the Charlestown abutment four-inch tongued and grooved spruce plank was used. The sheeting at piers 1, 9, and 10 and at the Charlestown abutment was held in place for driving by double waling attached to piles driven outside the line of the sheeting. At the other piers a frame was built, above water, supported by a curbing attached to certain piles in the outer rows of the foundation that were reserved for the purpose. The posts or vertical members of this frame were Wakefield sheet piling planks placed at intervals of from six to ten feet. These posts were connected by three lines of double waling bolted to the posts at three different levels. When the framework was completed it was lowered to the bottom, so as to enclose the bearing piles. The posts were driven, one by one, into the bottom, the frame having been built with sufficient flexi-



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bility to allow this to be done. Then sheet piling was driven to fill the spaces between the posts, and the frame was bolted to the curbing piles. The curbing was afterwards used to support the traveller bearing the chute used for laying the concrete. Clay and stones were dumped into the water around the outside of each coffer-dam, to fill up the part of the excavation left outside the sheeting.

At pier 6 the concrete was deposited so rapidly that at one place there was a depth of eight feet of unset concrete in the coffer-dam. The outward pressure of this concrete caused the dam to open at the northeast corner, and a very troublesome leak was the result. At pier 3 the outward thrust of the concrete bulged the coffer-dam badly on the north side, and the contractor was allowed to strengthen the dam against internal pressure by iron rods extending entirely across the dam a little above the level of the concrete already laid, and fastened by nuts on the outside of the sheeting. These rods were placed in position by divers. The coffer-dams at piers 4 and 5 were stayed with similar bolts inserted before the frame was lowered into place.

The sand and gravel for the concrete were dredged from the harbor near Shirley gut, and were brought to the work on a lighter. The gravel is composed chiefly of rounded pebbles of various sizes. The sand is clean and sharp, composed partly of coarse particles and partly of moderately fine ones. The sand was separated from the gravel by hand screening. All the cement used was English Portland cement. The mixing was done in a continuous mixing machine in which a shaft with paddles revolves in an inclined trough. The sand, gravel, and cement were shovelled continuously into the trough, as nearly as possible in the correct proportions, while a stream of water, regulated by a valve, ran in at the upper end. The mixed concrete issued from the lower end of the trough, and was carried in wheelbarrows to the place where it was used. This method requires close watchfulness on the part of the inspector, who must see that the proper quantity of cement is shovelled in.

The method used by the contractor for depositing the concrete in the pier foundations (except the upper layer, which the contract required to be deposited when the coffer-dam was free of water) was the method of laying it *en masse* under water, through a chute. The tube of the chute is about 14 inches in diameter at the bottom and about 11 inches at the neck, above which is a hopper to receive the concrete when it is dumped from the wheelbarrows. The tube is made in removable sections bolted together through outside flanges, so that its length can be adapted to the depth

of water in which it is to be used. The chute was suspended by a differential hoist from a truck moving on a travelling frame. The frame could be moved on a track from end to end of the coffer-dam, while the truck's motion on the frame was from side to side of the pier, and the hoist gave means for raising or lowering the chute. The method of operation was as follows :

The foot of the chute was allowed to rest on the bottom, and was filled with concrete dumped from wheelbarrows. The chute was then raised slowly from the bottom, allowing a part of the concrete to run out in a conical heap at the foot, while the loss was made good by dumping in more concrete at the top. The truck bearing the chute was then moved from side to side of the dam, so as to leave a ridge or bank of concrete crosswise of the pier, the chute being kept always filled or nearly filled by dumping more concrete into the hopper. The height of the ridge of concrete was regulated by the height to which the foot of the chute had been raised from the bottom. When the ridge was completed across the dam, the traveller supporting the truck was moved a short distance lengthwise of the pier, and the truck was moved back again across the dam, parallel to its former course, allowing the concrete to run out over the edge of the bank first deposited, widening it on the side to which the traveller had been moved, and this process was continued until the whole area of the foundation was covered with a layer of concrete, upon which, when it was sufficiently hardened, another similar layer or course could be deposited.

The thickness of each course depended upon the height to which the foot of the chute was raised above the top of the preceding course. Courses were laid up to six feet in thickness, but it is thought that the best results were attained with a thickness of two or two and one-half feet.

If the bank is made too high, or if the bottom (or the top of the preceding course) is very uneven, or if the piles interfere with the motion of the chute, or if the chute is moved along or raised too rapidly, the concrete is likely to run out so fast as to empty the chute entirely before the flow can be checked. In this event the "charge" is said to be "lost," and the chute must be lowered again to the bottom and refilled. When the charge is lost the water rises inside the chute to the same level as that outside, and into this water the concrete must be dumped until the water is wholly displaced or absorbed by the concrete. This has a tendency to wash the concrete, and to separate the cement from the sand and gravel, and as it generally takes a cubic yard or more



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DEPOSITING CONCRETE. PIER No. 5.

of concrete to displace all the water in the chute, there is danger that a rather large body of badly washed concrete will be deposited whenever the charge is lost. This danger threatens not only when the charge is accidentally lost, but whenever work is begun in the morning or after the mid-day intermission; for whenever the work stops the charge must be allowed to run out lest it set in the chute.

To obviate partially the evil of washed concrete, the contractor was directed, whenever work was begun after an intermission, or whenever the charge was lost or water leaked into the chute, to throw into it, before each wheelbarrow-load of concrete, until the water was displaced, a quantity of dry cement. He was also directed to begin work after an intermission with the chute near the centre line of the pier, so that any body of washed concrete resulting would be completely surrounded by sound concrete.

After the workmen and the inspector had gained experience with the chute, the accidental loss of the charge was not a frequent occurrence, and the danger of an occasional body of partly washed concrete, surrounded as it must be by good concrete, was not looked upon as a very serious matter. When concrete was laid in the coffer-dams at piers 3 and 4, which were tied by cross-bolts to keep them from spreading, the chute had to be hoisted over each set of bolts, making, besides those which were accidental, about seven losses of charge per day instead of two in the other piers. It was thought that it might be possible to devise a plug or piston to be put into the chute ahead of the concrete, which, being thrust to the bottom by the weight of the concrete, should push the water before it, and expel it from the bottom of the chute without allowing it to mingle with the concrete. The piston, of course, would be lost at each operation, and would remain imbedded in the concrete.

The problem was complicated by the fact that the chute, as has been stated, was 14 inches in diameter at the foot, but only 11 inches at the neck, making necessary an expanding piston, that could pass through the 11-inch neck, but would nevertheless fill the 14-inch tube below, and would not tip over under the pressure of the concrete in any part of the tube.

After an unsuccessful trial with a single cone of canvas, a piston was devised consisting of two truncated cones of canvas, one flaring downwards to force the water ahead, and the other flaring upwards to prevent the particles of concrete from forcing their way past the piston, and also, by the aid of the outward pressure of the concrete, to help to guide the piston and prevent it from turning over. The canvas was stiffened

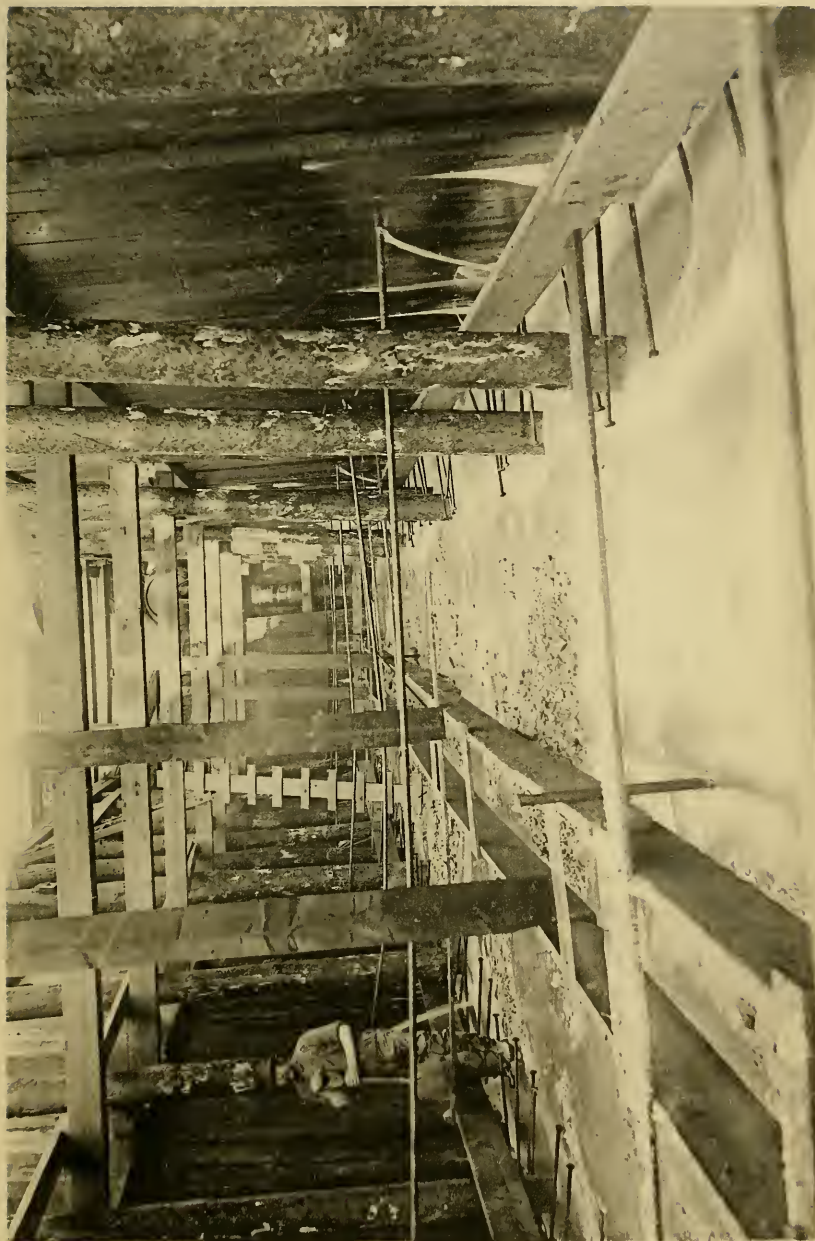
and held against the sides of the chute by longitudinal ribs of spring steel wire. The waist was filled with a thick block of wood to which all the ribs were attached, and to which were attached additional guides of steel to prevent overturning, and a rope for lowering the piston to the surface of the water and afterwards preventing it from descending too rapidly. This piston was successful in preventing the washing of the concrete. Only a very little water forced its way past the piston, and that little was soon absorbed by the concrete. But it was thought that the cost would be large, and the evil to be avoided was not so great as to justify the outlay; and so, after the experimental pistons were used, no others were made.

A difficulty sometimes met with in using the chute is that when a sudden rush of concrete takes place, even if the charge is not entirely lost, the concrete within the chute often falls far below the level of the water outside. The outside water then, especially if there is a deficiency of sand in the concrete, is likely to force its way through the concrete remaining in the bottom of the chute, tending to separate the cement from the sand and gravel, and making the concrete too wet, and so threatening a complete loss of charge. If there are any leaks in the joints of the chute, water comes in and tends to cause loss of charge, and this leakage is especially troublesome when the concrete in the chute falls below the level of the water outside.

The chute seems to work best when the concrete is mixed not quite moist enough to be plastic. If it is mixed too wet the charge is likely to be lost; if very dry there is a tendency to choking of the chute. The working of the chute is affected also by variations in the proportions of sand and gravel. With gravel in excess the outside water too readily forces its way in at the bottom. With an excess of sand the concrete tends to clog in the chute.

Sometimes when the concrete becomes clogged in the upper part of the chute, the concrete below the clogged place continues to flow out, leaving a vacant space into which water forces itself through the concrete remaining in the bottom of the chute. When the clogged concrete above is loosened, it falls into this body of water, which, unable to find exit by the way through which it entered, is displaced by the falling concrete, and rises into the hopper, sometimes to a level considerably above that of the water outside.

In piers 3, 4, and 5 the contractor was allowed, as has been mentioned, to cut off the high-grade piles at a level only a few feet higher than that at which the low-grade piles were cut off. In these piers it was thought wise to provide for



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binding the concrete together both longitudinally and transversely. The contractor was accordingly directed to procure iron rods about 15 feet long. Second-hand iron rods of various lengths and from $\frac{3}{4}$ to 2 inches in diameter were used. Some of these rods were already provided with heads or nuts at the ends. The others were heated and bent over at the ends to give them a hold on the concrete. On top of each layer of concrete these rods were deposited, on one layer crosswise and on the next layer lengthwise of the pier. The transverse rods were spaced sometimes 5 feet and sometimes $3\frac{1}{2}$ feet apart. Two lines of longitudinal rods were laid, one line near each side of the pier, the rods overlapping a foot or two at the ends.

As the concrete foundations are to be more or less exposed to the action of salt water, especially after the sheeting shall have disappeared, it was thought prudent to obtain some information as to the occasional destruction of Portland cement concrete by sea water. It was found that though there are several opinions as to the cause of such failures and more than one theory as to the chemical action involved, the best authorities believe that if the concrete is made from a cement of normal composition, mixed with sand and gravel in such proportions as to make a nearly impervious mass, and especially if the concrete is not exposed to any unbalanced water pressure that would tend to produce a current through the mass, there is but little danger of a failure.

As the concrete foundations of the Charlestown bridge are wholly submerged even at low tide, and are not exposed to any unbalanced water pressure, there is no tendency to the formation of currents through the concrete. But the method of measuring and mixing the materials being such that some variation in the proportions is inevitable, the contractor was directed to use such an excess of cement, above the proportions that the contract called for, as to assure the proper richness in all parts of the concrete. It was assumed that one barrel of Portland cement mixed with sand and gravel in the proportion of 1 : 2 : 5, the proportions required by the contract, would make 22 cubic feet of concrete. In an actual test, using the above proportions of the sand and gravel used on the work, one barrel of cement made 22.04 cubic feet.

In order that cements of abnormal composition might be rejected, it was deemed prudent, in addition to the usual physical tests, to make a chemical analysis of a sample from each lot of cement furnished to the contractor. The analyses are recorded in Table II. Lots 4 to 18 inclusive

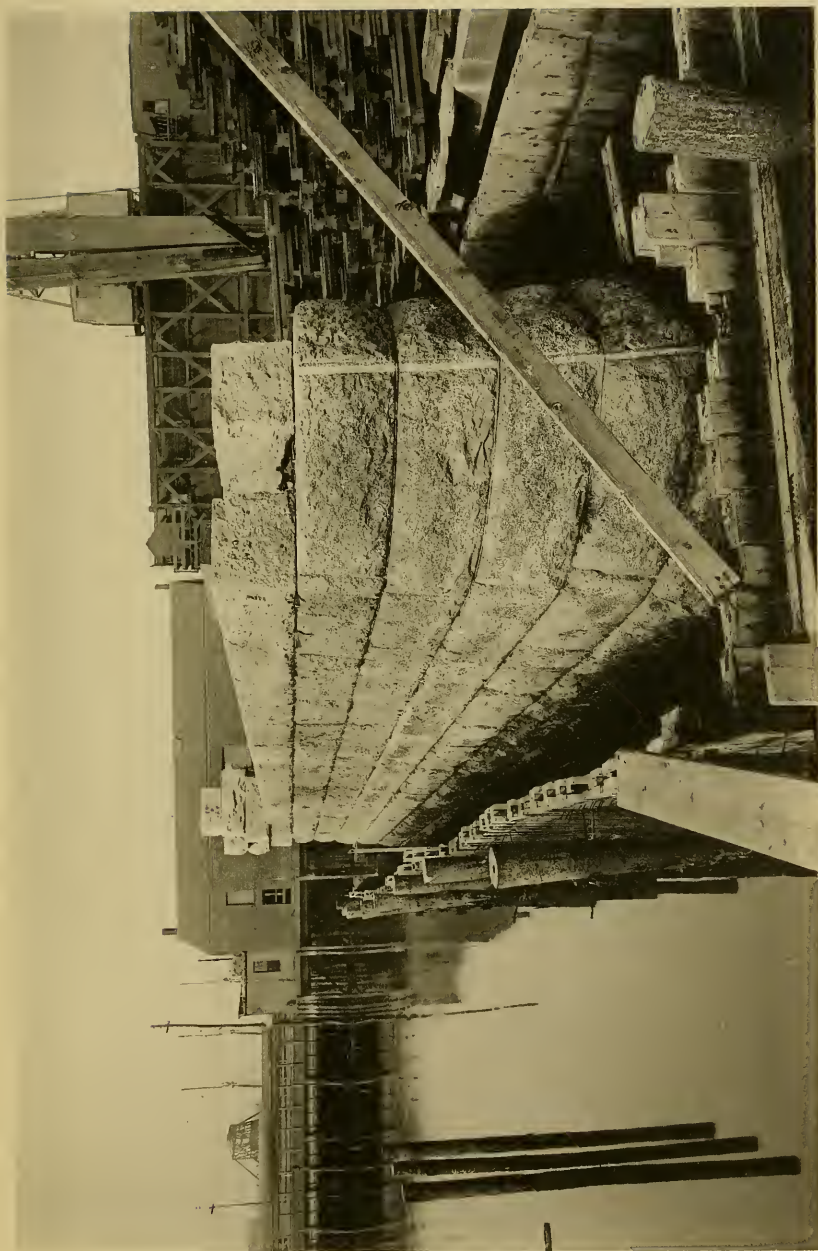
were analyzed by Dr. Arthur A. Noyes, lots 19, 20, and 21 by Henry J. Williams. Lots 1 to 3 were not analyzed.

TABLE NO. II.
ANALYSES OF ENGLISH PORTLAND CEMENT.

Lot number.	Sample number.	Per cent. of H_2O in original sample.	Per cent. of CO_2 in original sample.	PER CENT. OF IGNITED SAMPLE.							
				Line.	Silica.	Alumina.	Sesquioxide of iron.	Magnesia.	Sulphuric acid.	Alumina and oxide of iron.	Undetermined.
				CaO	SiO_2	Al_2O_3	Fe_2O_3	MgO	SO_3	$Al_2O_3 + Fe_2O_3$	
4 . .	1 . .	0.95	0.85	62.35	22.75	8.15	2.60	1.10	1.45	10.75	1.60
5 . .	2 . .	...	...	60.80	...	...	...	...	1.25	...	37.95
6 . .	5 . .	...	...	58.75	20.25	...	...	...	1.40	15.35	4.25
7 . .	6 . .	...	...	60.65	23.20	...	...	...	1.40	11.55	3.20
8 . .	7 . .	0.70	0.45	59.90	24.00	8.60	3.15	1.20	1.50	11.75	1.65
9 . .	9 . .	...	...	61.80	24.10	...	...	...	1.50	12.05	0.55
10 . .	10 . .	...	...	64.10	22.30	...	...	...	1.45	11.30	0.85
11 . .	12 . .	1.65	0.50	60.35	24.05	9.00	3.40	1.20	1.95	12.40	0.05
12 . .	13 . .	1.75	0.35	63.75	22.45	8.40	2.90	0.95	1.65	11.35	...
13 . .	14 . .	0.20	0.35	61.05	23.30	8.80	2.80	1.10	1.50	11.60	1.45
14 . .	15 . .	0.55	0.20	60.65	23.60	8.60	2.85	1.15	1.55	11.50	1.55
15 . .	16 . .	0.90	0.35	62.60	22.70	8.15	2.95	1.15	1.20	11.10	1.25
16 . .	17 . .	0.50	0.45	62.00	22.55	8.70	2.70	0.70	1.85	11.40	1.50
17 . .	18 . .	0.70	0.35	62.90	22.20	7.65	2.90	1.05	1.50	10.55	1.75
18 . .	19 . .	0.60	0.35	61.55	23.00	8.65	3.15	0.90	1.65	11.75	1.15
19 . .	21 . .	0.68	0.16	62.09	23.44	7.16	3.51	0.96	1.92	10.67	0.92
20 . .	22 . .	1.36	0.49	56.74	26.24	7.53	3.56	1.19	2.40	11.09	2.34
21 . .	23 . .	0.30	0.47	60.28	22.96	8.21	3.94	0.89	1.22	12.15	2.50

NOTE. — Lots 17 and 18 were rejected on the "barrel-test," but after storage for $2\frac{1}{4}$ months lot 17 was again tested, and was allowed to be used. Lot 20 was rejected for abnormal percentage of SO_3 and unsatisfactory setting qualities.

Owing to the liability of the coffer-dams to be distorted by the pressure of unset concrete, it became important to ascertain how long it would take concrete, laid under water with the chute, to set and harden sufficiently to sustain another layer of concrete on top of it. A "barrel-test" was therefore devised. Concrete was laid through a small chute in a cement barrel placed in a large hogshead filled with salt water, so that the conditions obtaining in the actual work were closely reproduced. In some of the experiments the bottom of the cement barrel was left in; in others it was left out. In these tests it was found that there was a marked difference in the behavior of the lots of concrete tested. The best specimens became hard enough in 24 hours to retain their form and to sustain some weight when the barrel was removed, and at the end of a week under water such specimens were so strong as to require many blows of a heavy peen hammer to split them in two. In these specimens



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the cement and gravel remained well mixed together, there were hardly any voids, and only a small amount of spent cement, separated from the gravel, was to be found in the bottom corners of the barrel and spread in a thin layer on the top of the concrete. Samples made from other lots of cement would be so weak at the end of 24, or even 48, hours as to fall apart when the barrel was removed, and even after a fortnight had elapsed such specimens were still easily broken and crumbled. In these cases a good deal of the cement had separated from the gravel and had found its way to the bottom, or, when the barrel was open at the lower end, had run out into the hogshead, and remained there in a spent and inert state. In such samples, too, the layer of spent cement on top of the concrete was usually thicker than in the better samples. The concrete remaining in the middle part of the barrel, having lost a larger part of its cement and some of its sand, was honey-combed with voids.

Such marked differences being observed in the action of different lots of the same brand of cement, it was decided to apply the barrel-test to all subsequent deliveries. As a result the contractor was directed not to use lots 17 and 18, and was allowed to use lot 16 only in certain portions of the work. Lot 17, after being stored a little more than two months, was again subjected to the barrel-test, and was found to have improved so much that the contractor was allowed to use it. The inference is that lots 16, 17, and 18 were too fresh when first tested.

The contract required the top layer of each concrete foundation to be laid when the coffer-dam was free from water. When the coffer-dams were pumped out it was found that the leakage through the sheeting was considerable. At almost every pier a strong current of water was always running lengthwise of the pier, and for this current channels had to be provided. At first the water was allowed to run in side channels along the sheeting, but the coffer-dam at pier 6, the one that opened at the eastern end from the pressure of unset concrete, leaked so badly that side channels alone would not have been sufficient to convey the leakage to the pump. The contractor was therefore directed to leave another channel along the middle of the pier, to be filled with concrete after the first course of stone was laid. This plan worked so well that it was followed in other piers.

The contract provided for wrought-iron anchor-bolts 20 inches long, screwed 5 inches into the sheeting at a level 8 inches below the top of the concrete. The anchor-bolts were intended to project 15 inches into the solid concrete so

as to hold the sheeting planks in place after the completion of the work. This plan was of course interfered with by the side channels, which were often more than 15 inches wide. The concrete with which the channels were to be eventually filled, after the first course of masonry should be put in place, would necessarily be laid in flowing water and in other respects under unfavorable conditions, and in any case would be but poorly bonded to the main body of the pier. The contractor was therefore directed to lengthen the anchor-bolts to $3\frac{1}{2}$ feet. The anchor-bolts will therefore serve both to secure the sheeting and to bond the concrete that fills the channels to the main body of the work.

The concrete that was laid after the coffer-dams were pumped out worked best when mixed wet enough to be slightly plastic. If mixed too dry it was apt to be washed and undercut by the water running in the channels. If too wet it could not be properly rammed and was unsatisfactory for obvious reasons, but when given the right consistency it would oppose a considerable resistance to even a rather strong current of water.

The top layer of concrete set and hardened quickly, and, except in pier 8 where it was laid when the temperature of the salt water was below 32° F., was strong enough to receive stone-work 24 hours after it was laid.

The first four courses of stone-work were generally laid when the coffer-dam was pumped out. Then, generally, the pump was removed for use elsewhere, and the masonry was continued by tide work until it reached high-water level. Part of pier 10 was laid in very cold weather, and was then exposed to thawing and freezing for the rest of the winter, but in the spring the mortar showed injury in only a few places.

The work under contract is progressing rapidly, and it is expected that the ten masonry piers will be completed by November 1, the two abutments by December 1, and that the eight spans of steel superstructure will be erected by January 1, next.

Respectfully submitted,

WILLIAM JACKSON,
Chief Engineer Charlestown Bridge.

APPENDIX A.

THE CONTRACT WITH THE WEST END STREET
RAILWAY COMPANY.

BOSTON, Dec. 14, 1896.

The following was passed at a meeting of this Commission duly called and this day held:

" *Whereas*, It seems expedient to make sundry amendments in the contract with the West End Street Railway Company, the execution and delivery of which were authorized at the meeting of Monday, December 7:

" *Voted*, That the authority to deliver said contract is hereby revoked.

" *Voted*, To make a contract with the West End Street Railway Company relating to the use of the subway of the tenor and in the form following, and to authorize a majority of the members of the Commission to execute such contract in the manner therein provided and to deliver the same."

A true copy.

Attest:

(Signed) B. LEIGHTON BEAL,

Secretary.

At a meeting of the Directors of the West End Street Railway Company duly called and held Dec. 14, 1896, at which a quorum was present, the following vote was passed:

Voted, That the president is authorized to execute in the name and with the corporate seal of the company a contract for the use of the subway in the form which is now presented to the meeting and which is to be spread upon the records, such execution to be subject, however, to the ratification of the stockholders, and when ratified the president is authorized to deliver the same as the contract of the company.

A true record.

Attest:

(Signed) PRENTISS CUMMINGS,

Clerk.

At a meeting of the stockholders of the West End Street Railway Company, duly called and held this 15th day of December, 1896, at which a quorum was present, the following vote was duly passed:

Voted, That the contract for the use of the subway submitted to this meeting by the Board of Directors is approved and the action of the president in executing the same in the name and with the seal of the company is ratified and confirmed, and the president is authorized to deliver the same as the contract of the company.

A true copy of the call of said meeting is hereto annexed.

A true record.

Attest:

(Signed) PRENTISS CUMMINGS,

Clerk.

WEST END STREET RAILWAY COMPANY.

Special Meeting.

A special meeting of the stockholders of the West End Street Railway Company will be held at Wesleyan Hall, No. 36 Bromfield street, Boston, on Tuesday, the fifteenth day of December, 1896, at 12 o'clock, noon, for the following purposes:

1. To consider a contract to be made by the Company for the use of the Subway, which will be submitted by the Board of Directors, and to determine whether the stockholders will ratify and confirm the execution thereof by the president, and will authorize its delivery as the contract of the Company.

2. To transact such other business as shall properly come before the meeting.

The transfer books will be closed from close of business Saturday, December 12th, until opening of business, Thursday, Dec. 24, 1896.

PRENTISS CUMMINGS,

Clerk.

BOSTON, Dec. 7, 1896.

CONTRACT BETWEEN THE CITY OF BOSTON ACTING BY THE
BOSTON TRANSIT COMMISSION AND THE WEST END STREET
RAILWAY COMPANY FOR THE USE OF THE SUBWAY.

Parties. This contract made this seventh day of December in the year one thousand eight hundred and ninety-six by and between the city of Boston by the Boston Transit Commission acting by a majority of its members thereto duly authorized under the authority vested in it by the acts of the Commonwealth of Massachusetts Chapter 478 of the year 1893 Chapter 548 of the year 1894 Chapter 440 of the year 1895 and Chapter 492 of the year 1896 and under all other powers to it hereto enabling party of the first part the Boston Transit Commission hereinafter called the Commission also acting by a majority of its members thereto duly authorized and joining in the grants hereinafter made in its own behalf in exercise of the powers conferred upon it by the acts aforesaid but not binding its members in their personal capacity by any agreement herein contained and the West End Street Railway Company party of the second part.

Grant. WITNESSETH The party of the first part in consideration of the covenants and agreements of the party of the second part herein contained hereby grants to the party of the second part for the term hereinafter stated and subject to the reservations, restrictions and limitations hereinafter set forth the entire use and occupation of the subway now constructed or hereafter to be constructed by the Commission under the authority of the aforesaid acts the same to be used however only for locations of the railway tracks of the party of the second part for the operation of its railway and for the purposes hereinafter expressly enumerated including in such uses the right to construct maintain renew and use such tracks together with switches cross-overs connections wires appliances fixtures electrical apparatus and all other machinery and equipment which may be necessary or proper from time to time for the convenient operation of the railway of said party of the second part the carrying on of its lawful business in the subway and the performance of its agreements hereinafter contained.

The word subway as used above and wherever used in this instrument shall include all the subway subways tunnels entrances approaches connections sidings stations and appurtenant structures and fixtures of every kind which the Commission has constructed or hereafter may construct under the authority of the aforesaid acts and wherever in this instrument a portion of the subway is referred to there shall be meant a continuous and connected portion of the subway as above defined unless a different signification is apparent. Definition of subway.

The subway is to be constructed substantially according to the route and with the stations indicated on the plan hereto annexed and marked "A" so far as its route is exhibited thereon and similar to the portions already completed. Said plan is entitled "Boston Subway — Progress to Aug. 15, 1896."

If any street railway company is now using and is entitled by virtue of an existing contract to use the tracks of the party of the second part in any portion of the route which is or hereafter may be occupied by the subway then the party of the second part may permit such street railway company to use during the whole or any part of the term of this grant the tracks which may be laid in the corresponding portion of the subway upon such terms as may be agreed upon between the party of the second part and such other street railway company. Use of tracks by another street railway company.

If any corporation having the right to carry passengers in the city of Boston shall by authority of law succeed by purchase lease or otherwise to all the property rights and franchises of said West End Street Railway Company the said railway company may assign to such succeeding corporation all the rights privileges and powers granted and conveyed by this contract provided however and on condition that said succeeding corporation shall assume all the duties obligations and undertakings herein imposed upon said West End Street Railway Company.

The use of the subway shall begin so soon as a reasonable time after its completion has been allowed the party of the second part for the equipment thereof. Beginning and length of term.

The Commission shall determine when the use shall begin and shall notify the party of the second part of its decision and if in the judgment of the Commission any portion of the subway can be advantageously used before the completion of the whole then the use of such portion shall begin when in the opinion of the Commission a reasonable time after the completion of such portion has been allowed to the party of the second part for the equipment thereof and after notice to that effect has been given to the party of the second part.

The rights herein granted to the party of the second part shall continue for the term of twenty (20) years from the time when the right to use the subway or any portion thereof first accrues.

As compensation for the use of all the above premises and property the party of the second part agrees to pay in each year to the city of Boston a sum equal to four and seven-eighths ($4\frac{7}{8}$) per centum of seven million dollars or four and seven-eighths ($4\frac{7}{8}$) per centum of the net cost of the subway if such net cost be less than seven million dollars said net cost to be computed in the manner below provided. Said compensation is to begin to accrue from the time when the use of the said premises and property begins under the foregoing provi- Compensation.

sions of this instrument and in case the right to use any portion of the said premises and property shall begin before the right to use the whole then compensation shall be paid for the use of such portion and shall begin to accrue with its use and shall be at the above named percentage of the net cost of such portion to be computed as below set forth.

And the party of the second part agrees also to pay in each year after it shall have acquired the use of all portions of the subway such additional compensation if any as may be determined by a computation of the number of passages made by cars in and through the subway as hereinafter provided that is to say in case the amount computed as below provided upon the basis of the number of such passages exceeds the amount determined by a percentage of the net cost of construction then the party of the second part agrees after so acquiring the use also to pay as compensation the amount of such excess. It is therefore agreed that the compensation for any quarter of a year after the party of the second part shall have acquired the use of all portions of the subway shall not be less than a sum computed by charging a toll of five (5) cents for each passage made through the subway by a car not exceeding twenty-five (25) feet in body length and at a proportionately greater rate for each car of greater length it being understood that any car which enters or passes through the subway or a portion thereof in one direction and then reverses its direction within the subway and makes a return trip shall be considered as making two passages but otherwise the passing through the subway shall be considered as a single passage only and it being also understood that no opening is to be made under the authority of existing statutes by which cars shall enter the subway from Washington street or Devonshire street. Cars used only for the conveyance of the United States mails or for construction or repairs or as motor cars only and carrying only persons necessary for such purposes shall not be included in computing the passages for which a toll is to be charged. The party of the second part shall keep a record of the passages of cars for which payment may be charged as above provided and shall report the same quarterly when making payment for the use of the subway.

In determining the net cost of the premises and property or of any portion thereof there shall be included all lawful expenditures of every kind incurred by the Commission on account of the acquisition and construction thereof or of the portion to be used as the case may be including the sums paid by the Commission to any persons by way of damages for property taken or injured or for personal injuries suffered the incidental expenses of the Commission incurred under the authority of said acts the sums paid to the Commission for salaries of its members and also such interest at the rate of four (4) per centum per annum as shall have accrued up to the time when the use by the party of the second part is to begin on any debt incurred by the city of Boston at the request or in behalf of the Commission in acquiring or constructing the said premises or property as aforesaid or the portion thereof in question as the case may be.

From the gross cost so ascertained there shall be deducted any money which the Commission may then have received from the sales or other disposition of any property or rights which may have been included in estimating the gross cost and there shall be also deducted at a fair valuation to be then

made by the Commission any property or rights so included which though not actually sold or otherwise disposed of will not be needed in the judgment of the Commission for the purposes for which the premises and property are to be used by the party of the second part and when said property and rights have been actually sold or otherwise finally disposed of an adjustment of the cost of the subway and its additions shall be made upon the basis of the actual proceeds received from such final disposition for the purpose of determining the amount on which a percentage is to be subsequently paid as compensation. The right is hereby reserved to the Commission and after the expiration of the Commission to the city of Boston to dispose of any property or rights so valued as aforesaid but neither this reservation nor the right of deduction above provided shall apply to any property or rights within the subway.

At any time when the use of the whole or any portion of the premises and property is to begin or as near thereto as is practicable the Commission shall make out and submit to the party of the second part a statement of the net cost computed as above showing with reasonable detail what is included therein.

If at any time during the continuance of the term of this grant the party of the second part shall be deprived in whole or in part of the use of the premises and property by any cause growing out of the act of God public enemies mobs riots the falling or settling of buildings bursting of pipes outside the subway explosions of gas or works or excavations carried on or permitted by said city or other public authority or the filling or caving in or other physical obstruction of the subway or any part thereof not due to the negligence of the party of the second part or by the location maintenance or use of the wires or other apparatus which the city is hereinafter authorized to maintain in the subway then the amount above fixed as compensation or a just and reasonable part thereof shall be suspended or abated during such deprivation.

The compensation for the use of the subway or any portion thereof shall be paid to the city of Boston in quarterly payments on the last day of December March June and September in each year and at the rate aforesaid for any uncompleted quarter of a year.

Said party of the second part shall suitably lay and maintain in first-class condition railway tracks in proper place in the subway together with the appointments and apparatus necessary for the safe and convenient operation of the same and shall provide and maintain all wires electrical or other apparatus or equipment necessary or convenient for the furnishing of power and light therein and shall further provide requisite pumps fans and ventilating apparatus and in general shall completely equip and furnish the subway with all machinery piping apparatus and furniture proper and adapted thereto and necessary for the convenient maintenance and operation of a railway therein and for the safety and accommodation of the passengers upon said railway.

All tracks wires appliances fixtures machinery equipment furniture and apparatus provided by said party of the second part shall be and remain the property of said party of the second part so long as it continues to occupy and use the subway under the provisions of this contract and upon the termination of such use and occupation the party of the first part hereby agrees to take and pay for all such property at its then

Equipment
of subway.

fair value to be determined by the Board of Railroad Commissioners and the party of the second part hereby agrees to deliver to the party of the first part all such property at the said valuation.

Power and
light.

The power to be used in the operation of the railway in the subway and of the apparatus placed therein shall be either electricity compressed air or some agent the use of which will not be accompanied by smoke steam or any noxious products which might impair the purity of the atmosphere within the subway and the use and manner of use of any motive power shall be subject to the approval of the Commission the use of electricity however as a motive power in the subway being hereby approved.

Neither steam nor animals shall be used within the subway as a motive power except temporarily in cases of emergency.

Said party of the second part shall suitably and adequately and to the satisfaction of the Commission light the subway and the cars running therein by electricity or may from time to time in whole or in part use such other illuminating agents as may be approved by the Commission but no illuminating gas of any description shall be used therein nor any illuminating agent which is explosive.

Repairs.

Said party of the second part shall maintain the subway except as to repairs below excepted in good order and condition as a complete structure adapted to the maintenance and use of lines of railway and shall at all reasonable times be entitled to a permit to open the streets and other public grounds of said city for the purpose of making requisite repairs to the subway and when the right to use the subway shall terminate shall restore it to the city in good condition except as to repairs not obligatory upon said party of the second part.

All repairs to the subway shall be at the sole cost and expense of the party of the second part except such repairs as are made necessary by the act of God public enemies mobs riots the falling or settling of buildings bursting of pipes outside the subway explosions of gas or works or excavations carried on or permitted by said city or other public authority or by the location maintenance or use of the wires or other apparatus which the city is hereinafter authorized to maintain in the subway and if repairs should be made necessary by any of said excepted causes then such repairs may be made by the party of the second part and the reasonable cost and expense thereof deducted from the compensation subsequently due and payable hereunder.

Liability for
damages.

The party of the first part shall not be responsible to the party of the second part for damages of any description resulting from any defects in the subway whether structural or arising out of want of repair or from any cause after the use of the same by the party of the second part has begun as hereinbefore provided unless such damage result from the location maintenance or use of the wires or other apparatus which the city is hereinafter authorized to maintain in the subway nor shall it be responsible for any damages resulting to persons or property in the operation and use of the subway including all parts thereof whether on property belonging to the party of the first part or upon property the fee of which belongs to other parties and the party of the second part shall hold the party of the first part harmless and indemnified therefrom and shall at its own expense upon due

notice from said party of the first part defend all suits and other proceedings of every description whether at law or in equity which may be brought against said party of the first part its officers servants or agents by reason of any liability arising out of the maintenance operation and use of any portion of the subway or of the railways machinery and apparatus therein and accruing after the right to use such portion has begun as hereinbefore provided and shall satisfy all final judgments of legal tribunals rendered in such suits and proceedings but the foregoing provisions shall not apply to legal proceedings to recover for loss or injuries growing out of the act of God public enemies mobs riots the falling or settling of buildings bursting of pipes outside the subway explosions of gas or works or excavations carried on or permitted by said city or other public authority or the location maintenance or use of the wires or other apparatus which the city is hereinafter authorized to maintain in the subway.

The party of the second part agrees that it will make no claim against the party of the first part for any damage for removing upon the order of the Commissioner its surface tracks from Tremont street between Boylston street and Scolly square and from Boylston street between Park square and Tremont street and such other tracks as the Commission may order to be removed under the authority of the aforesaid acts provided that during the term of this contract the right to lay maintain and use tracks on the locations from which the tracks are so removed be not granted nor permitted to any other person or corporation for street railway purposes and the party of the second part agrees at its own expense to restore and leave in good condition the pavement of that portion of the streets occupied by the tracks so removed.

The members of the Commission the Governor of the Commonwealth the Board of Railroad Commissioners and their respective engineers and the Mayor and the City Engineer of Boston shall at all times have free entry to the subway for the purpose of inspecting the same.

The party of the second part shall keep the subway thoroughly clean and in good order and condition at all times except as herein excepted shall by use of pumps keep the same free from unnecessary dampness and shall by artificial ventilation when needed keep the air therein pure and shall keep the stations and their approaches free from ice and snow all which service shall be performed to the satisfaction of the Commission.

Said party of the second part shall have no right to make substantial alterations or additions in the subway unless with the approval of the Commission and after the termination of the existence of the Commission with the approval of the Mayor for the time being of the city of Boston and the Board of Railroad Commissioners nor shall it have the right to place therein or attach thereto except as hereinafter provided any structures machinery merchandise apparatus advertisements or property of any sort which are not necessary or proper for the operation of its railway therein and the performance of its agreements herein contained but the said party of the second part may place and maintain booths of suitable size and character upon each platform for the sale of newspapers magazines periodicals and books so far as the party of the first part has the power to grant the right to place and main-

Removal of
surface
tracks.

Inspection
by public
officials.

Subway to
be kept
clean.

Changes in
subway not
to be made
by railway
company.

Unneces-
sary struc-
tures.

Newspaper
booths.

tain said booths and in the event that it shall be determined by any court of competent jurisdiction that said party of the first part has not such power then no abatement of the compensation which the party of the second part herein agrees to pay for the use of the subway shall be allowed in consequence.

Changes in
subway by
Commis-
sion.

The Commission if it deems that public convenience and necessity so require may make such additions to or improvements or changes in the subway within the limits defined by existing acts as it sees fit and said party of the second part may and shall in like manner as hereinbefore provided equip and use the subway after such additions improvements and changes therein shall have been made and shall be under all the obligations and have all the privileges respecting the same which are above provided with respect to the subway and shall pay for such use four and seven-eighths ($4\frac{7}{8}$) per centum annually upon the net cost of such additions improvements or changes determined as hereinbefore provided provided however that the total annual compensation to be paid by said party of the second part in any way under this instrument shall not exceed the amount above specified namely four and seven-eighths ($4\frac{7}{8}$) per centum of seven million (7,000,000) dollars unless such compensation shall exceed that amount when determined by a computation of the number of cars using the subway in the manner above provided.

Obligations
of railway
company
confined to
portions in
use.

The obligations and liability of the party of the second part under the foregoing provisions of this instrument shall not in any event apply to any portion of the premises or property covered hereby or to any additions improvements changes or alterations thereof except in so far as the party of the second part may have the right to the use and enjoyment thereof under the provisions hereof at the time as to which it may be sought to impose such obligation or liability.

Wires, con-
duits, and
tubes.

The party of the second part may grant upon such terms as it may deem expedient to any person or corporation not authorized to carry on a railway business but authorized by law to use and maintain for other purposes wires conduits for wires or pneumatic tubes along any portion of the route of the subway the privilege of placing such wires conduits or tubes within a corresponding portion of the subway used by the party of the second part but only to such extent and for such time as may be practicable without interfering with the convenient operation of the railway and other apparatus which the party of the second part is hereby authorized to put therein. If the party desiring such privilege cannot agree with the party of the second part upon the terms of such grant the privilege to the extent and for the time above stated shall be so granted upon terms to be settled by the Commission but in any event the compensation for such privilege shall be paid to the party of the second part.

The city of Boston may without charge place in the subway such wires and apparatus as may be necessary for its police and fire-alarm service to be used however exclusively for such service and to be so located as not to interfere with the use of the subway which the party of the second part is hereby authorized to make. The location construction maintenance and repair of such wires and apparatus shall be subject to such reasonable directions and regulations as the party of the second part may impose or in case of any disagreement as the Commission may determine.

In the event of the failure of the party of the second part or its successor to pay the compensation herein fixed for the use of the subway for three months after such compensation shall have become due or in the event of a failure to maintain and operate a railway within the subway and if such failure shall have continued for three months then in either of said events the city of Boston shall have the right to terminate this contract and to reënter upon and repossess itself of the above-described premises and property unless such failure to maintain and operate grow out of the act of God public enemies mobs riots the falling or settling of buildings bursting of pipes outside the subway explosions of gas or works or excavations carried on or permitted by said city or other public authority or the filling or caving in or other physical obstruction of the subway not due to the negligence of the party of the second part or out of the location maintenance or use of the wires or other apparatus which the city is hereinbefore authorized to maintain in the subway. In case the right of reëntry and repossession above given shall be exercised all the tracks wires apparatus equipment and other property in the nature of fixtures of the party of the second part within the subway shall become the property of the city of Boston and be paid for by it at a valuation to be determined as hereinbefore provided for the occasion when the same are to be surrendered by the party of the second part at the expiration of said term of twenty years.

Default and
penalty.

Said party of the second part shall have no right at any time to remove from the subway any tracks wires apparatus equipment or other property necessary to the use and maintenance of the subway and the operation of a railway therein except for the purpose of repairs or renewal or for the substitution of equivalent structures property apparatus or equipment nor shall it have the right to sell or mortgage such property unless removed under the foregoing provisions.

Removal of
property by
railway
company.

In case of the termination of this contract prior to the expiration of the term of twenty (20) years under the foregoing provisions hereof and a reëntry upon the premises and property aforesaid and a repossession of the same by the city of Boston the party of the second part agrees to indemnify the said city for all loss and damages which it may in any manner sustain by reason of such termination during the residue of said term of twenty (20) years.

Indemnity.

In case there shall be any disagreement between the parties hereto respecting the amount of compensation due hereunder and the party of the second part shall pay more than it maintains to be justly due it may make such payment under protest and may thereafter bring proceedings in any court of competent jurisdiction to recover the excess and any amount which the Court may adjudge to have been paid in excess shall be repaid by the party of the first part with interest at the rate of four and seven-eighths (4 $\frac{7}{8}$) per centum per annum.

Recovery of
excessive
payment.

In respect to all matters arising under this contract where provision is made for action by the Commission or its approval of acts to be done by the party of the second part is required it is hereby provided and agreed that upon the termination of the existence of the Commission the authority to take such action shall vest in and the necessity of approval shall apply to the Board of Railroad Commissioners unless otherwise herein provided until some other tribunal shall be designated by law for such purpose but the provisions of this paragraph

Termination of the
existence of
the Commission.

shall not apply to the powers hereinbefore reserved to the Transit Commission to make additions to improvements changes or alterations in the subway or to dispose in a certain event of certain property and rights acquired by the Transit Commission.

The Com-
pany to be
subject to
law.

It is understood and agreed that the party of the second part and any other company running cars within the subway as aforesaid shall with respect to the railway and tracks located in the subway and the equipment use and operation thereof and transportation thereon have all the powers and privileges and be subject to all the duties liabilities restrictions and provisions set forth in the general laws which now are or hereafter may be in force relating to street railways and street railway companies and in any other laws or acts which are or may be applicable to the party of the second part or such other company so far as the same are not or may not be inconsistent with the grants herein specifically made.

In testimo-
nium.

In witness whereof the said parties hereto set their hands and seals the day and year first above mentioned the city of Boston executing this instrument by the Boston Transit Commission acting by a majority of its members thereto duly authorized and adopting a common seal the West End Street Railway Company causing its name and corporate seal to be affixed to these presents by its president thereto duly authorized and the Boston Transit Commission also signing in the capacity above stated in the first paragraph of this instrument by a majority of its members thereto duly authorized each member adopting the same common seal.

*The City of Boston
acting by the Boston
Transit Commission.*

{ GEORGE G. CROCKER,
CHARLES H. DALTON,
THOMAS J. GARGAN,
GEORGE F. SWAIN. [SEAL.]

*Boston Transit
Commission.*

{ GEORGE G. CROCKER,
CHARLES H. DALTON,
THOMAS J. GARGAN,
GEORGE F. SWAIN. [SEAL.]

THE WEST END STREET RAILWAY COMPANY

By SAMUEL LITTLE,
President. [SEAL.]

The foregoing contract is the contract referred to in the vote of the Boston Transit Commission passed Dec. 14, 1896, a certified copy of which vote is hereto attached.

(Signed) B. LEIGHTON BEAL,
Secretary.

The foregoing contract is the contract referred to in the vote of the Directors of the West End St. Railway Co. passed Dec. 14, 1896, a certified copy of which vote is hereto attached, and is also the contract referred to in the vote of the stockholders of the West End St. Railway Co. passed Dec. 15, 1896, a certified copy of which vote is hereto attached.

(Signed) PRENTISS CUMMINGS,
Clerk.

COMMONWEALTH OF MASSACHUSETTS

IN BOARD OF RAILROAD COMMISSIONERS, Dec. 30, 1896.

In the matter of the joint petition of the Boston Transit Commission and the West End Street Railway Company for the approval by the Board under the provisions of Chapter 478 of the Acts of 1893; Chapter 548 of the Acts of 1894; Chapter 440 of the Acts of 1895; and Chapter 492 of the Acts of 1896, of a contract made on the seventh day of December, 1896, by and between the City of Boston, acting by the said Boston Transit Commission, and the West End Street Railway Company, in relation to the subway in said city of Boston for the construction of which provision is made in the aforesaid Acts, an executed copy of which contract has been filed with said petition in the office of the Board,— now

After public notice, and after hearing all parties and persons desiring to be heard, and upon consideration of the subject-matter of said petition and contract, it is

Ordered, That the said contract, a copy of which is hereto annexed, be and the same is hereby approved.

By order of the Board,

(Signed) WILLIAM J. McCULLOUGH,

Assistant Clerk.

A true copy.

Attest:

(Signed) WILLIAM J. McCULLOUGH,

Assistant Clerk.

APPENDIX B.

EQUIPMENT OF THE SUBWAY.

Statement (furnished by the West End Street Railway Company) of the Progress of the Work of Equipping that Portion of the Subway between Church Street and Park Street, and between Pleasant Street and Boylston Street, as of Aug. 15, 1897.

TRACK.

Between the Public Garden entrance and the Park-street church the track is entirely completed, and work is in progress on that portion between Boylston street and Pleasant street.

The rails used are the standard of the American Society of Civil Engineers for steam railroads, and weigh 85 pounds to the yard. Each rail is protected for its entire length by a rolled steel guard of special section, weighing 43 pounds to the yard, which is securely bolted to the running rail.

The joints are of the continuous pattern, giving a base support to the rails.

Rolled steel tie plates are used on each tie.

The ties are of oak and chestnut, thoroughly treated with woodline to exclude moisture, thereby ensuring proper insulation, and also increasing their durability. The ties are laid in broken stone ballast.

Each rail joint is bonded with two 0000 copper bonds, and every 500 feet all the tracks are properly bonded together and cross connected, the return to the station being by 500,000-centimetre cables.

The switches and frogs are of special design. The switches are arranged to be thrown by levers, fastened in place by steel wedges.

OVERHEAD WORK.

An inverted wooden trough made of kiln-dried cypress lumber is securely fastened to the iron-work of the roof structure, and insulated with sheet rubber. Car-barn hangers are set flush into this trough and insulated with sheet rubber between the hanger and the trough. The insulating bolt, carrying a special mechanical clip designed by the railway company's engineers, supports the trolley wire, which is also of special design, being in shape like the figure 8, and having an area of about 362,000 centimetres. These hangers are placed 12 feet apart on straight track, and 6 feet apart on curves, making the construction at once very rigid, simple, and workmanlike, and almost entirely eliminating the arcing of the trolley.

The current will be taken temporarily from the present underground feeder system of the railway company, but in the very near future will be taken from cables installed in the new conduit now being constructed, which runs from the central power station to the Pleasant-street entrance of the subway.

The overhead work in the section from the Public Garden to Park street is entirely completed, and the work is progressing in the section south of Boylston street under Tremont street.

LIGHTING SYSTEM.

The subway will be lighted throughout by electricity, both incandescent and arc lamps being used. There will be in the section south of Park street about 700 incandescent lamps, and the stations will be lighted by 75 arc lamps, 55 being enclosed arcs and 20 being direct current arcs, which will be run from the lines of the Boston Electric Light Company.

The incandescent lamps are run in lines on either side of the subway and also between the tracks. The lamps are placed about 36 feet apart, and the line circuits are alternated so as to properly distribute the lamps. The regular railway circuit is used. The current for one of the circuits or lines will be supplied from the Dorchester Power Station, and that for the other lines from the Central Power Station. The lamps are run five in series. In the event of trouble with one lamp the other four lamps in the series would not be affected, but would continue to burn by reason of the alternating feature in the distribution of the circuits, so that it is very improbable that any trouble which might arise would cause the subway to be left in darkness. The station lighting by the arc lamps is so arranged that in the event of trouble on one circuit the current will be supplied from the alternate circuit.

Under the junction of Tremont and Boylston streets a large room has been arranged in which has been installed the switch-board for controlling the lighting of the subway, equipped with automatic circuit breakers, ammeters, double-pole, double-throw switches, etc., so that it would be possible in the event of an emergency to throw a portion of the incandescent lamps on to the circuit of the Boston Electric Light Company, although these will ordinarily be run from the railway company's power stations.

This work of installation is entirely completed in the section between the Public Garden and Park street, and is well in hand in the section south of Boylston street under Tremont street.

STATION EQUIPMENT.

On the platforms at the foot of the entrance stairways ticket offices are being constructed of suitable design for the carrying on of the passenger traffic, four being located at the foot of each staircase. These offices will be heated by electric heaters and lighted with incandescent lights. On the platforms at the foot of the exit stairways are located turn-stiles, through which exit may be made, but which bar entry to the platform.

FIRE PIPING.

A complete system of fire piping is being installed in that section of the subway between the Public Garden entrance and Park street, with frequent connection with the city service through four-inch pipes, the piping inside the subway being of three-inch wrought-iron, suitably equipped at frequent intervals with valves, fire hose, and nozzles. A complete circulation of water will at all times be maintained upon these pipes. Work will be begun some time during next month on the fire pipe system in that section of the subway under Tremont street south of Boylston street.

APPENDIX C.

AN ACT TO PROMOTE RAPID TRANSIT IN THE CITY OF
BOSTON AND VICINITY.

Be it enacted, etc., as follows:

SECTION 1. Section four of chapter five hundred and forty-eight of the acts of the year eighteen hundred and ninety-four is hereby amended by striking out the whole of said section and inserting in place thereof the following: — *Section 4.* Said corporation may mortgage or pledge to any corporation organized under the laws of the Commonwealth, as security for the payment of its bonds, its franchises, and any or all of its real or personal property and property thereafter acquired by it, including its interest in any elevated or surface railways, under or by virtue of any lease or operating contract.

SECT. 2. The first paragraph of section six of said chapter five hundred and forty-eight is hereby amended so as to read as follows: — *Section 6.* Said corporation may construct lines of elevated railway according to such plans or systems as the board of railroad commissioners may approve, to be operated by electricity or other motive power except steam, upon the following locations, and may equip, maintain, and operate engines, motors, and cars thereon, to wit:

SECT. 3. Section six of said chapter five hundred and forty-eight is hereby further amended by striking out in the seventieth line of said section the words “in Brattle square in Cambridge,” and inserting in place thereof the words: — on Murray street near Charles river in Cambridge to and, — by striking out in the seventy-third and seventy-fourth lines of said section the words “to and through Western avenue to Central square,” and inserting in place thereof the words: — thence over and through private land at a point at or near the junction of Massachusetts avenue and Main street to and through Lafayette square, — and by adding at the end of said section the following:

Fourth. — Commencing at a point near the corner of Washington and Castle streets; then upon and over Castle street to a point at or near its intersection with Village street; thence over and across the location, lands, and tracks of the Boston and Albany Railroad Company, at a height of not less than twenty feet above said tracks, to Corning street; thence across Corning street to private lands between Porter and Kirkland streets; and thence over, upon, and under said private lands by an incline, open cut, and subway under Pleasant street, to the subway now constructed or in process of construction by the Boston transit commission; thence from the northerly terminus of said subway by an open cut, incline, and elevated structure upon and over land acquired by the Boston transit commission, and Canal street to Causeway street; thence upon and over Causeway street to a new bridge now being built by said transit commission, under the provisions of said chapter five hundred and forty-eight; thence upon and over said new bridge to and through City square, Main street, Essex street, and Rutherford avenue, to Sullivan square, in that part of Boston known as Charlestown.

Fifth. — Commencing at a point on Washington street at or near Fay street; thence upon and over private lands, and crossing Dover street,

Shawmut avenue, Hingham, Middlesex, Emerald, Compton, Lucas, Paul and Castle streets to lands occupied by the Boston and Albany Railroad Company; thence over and across the location, lands, and tracks of said company, at a height of not less than twenty feet above said tracks, to Corning street; thence across Corning street to private lands between Porter and Kirkland streets; and thence over, upon, and under said private lands, by an incline, open cut, and subway under Pleasant street to the subway aforesaid.

Sixth. — Commencing at a point at or near the junction of Washington and Dudley streets; thence upon and over that part of Dudley street between Washington and Warren streets; and upon and over that part of Zeigler street between Washington and Warren streets; also from Dudley street, upon and over Guild row and Roxbury street, to Washington street.

Seventh. — Commencing at a point at or near the corner of Washington and Castle streets; thence upon and over private lands to Motte street or Orange lane; thence upon and over Motte street or Orange lane in part, and in part upon and over private lands, to Harrison avenue; thence upon and over Harrison avenue to Beach street; thence upon and over Beach street to Cove street; thence upon and over Cove street to Federal street, or upon and over the new street to be constructed by the city of Boston, to Atlantic avenue; thence upon and over Atlantic avenue, Commercial street and Causeway street to the said new bridge now in process of construction by said transit commission, and to Merrimac street.

Eighth. — Commencing at the corner of Harrison avenue and Beach street, upon and over Harrison avenue to Essex street; thence upon and over Essex street to Cove street.

Ninth. — Commencing at or near the corner of Motte street and Harrison avenue; thence upon and over Way street, Broadway extension, and upon and over the existing bridge or a new bridge to be built across Fort Point channel to West Broadway, in that part of Boston known as South Boston.

Said corporation may also construct such loop lines in connection with the locations herein granted, upon and over such streets or ways as may be necessary or convenient to turn its trains or reverse the direction thereof.

SECT. 4. Within the locations granted by paragraphs fourth and fifth of section three of this act no structure shall be placed upon or in the land or locations of the Boston and Albany Railroad Company, or upon or in the land authorized to be taken or acquired by the Boston and Providence Railroad Corporation under chapter five hundred and sixteen of the acts of the year eighteen hundred and ninety-six, entitled "An Act to provide for a union station for passengers on railroads entering the southerly part of the city of Boston;" and no land shall be taken or location built upon within the limits of land authorized to be taken or acquired by said last-named corporation, under said chapter, without the consent of the directors of the Boston and Albany Railroad Company in any case affecting said company, and of the Old Colony Railroad Company in any case affecting said company, or of the board of railroad commissioners.

SECT. 5. Whenever said corporation shall request said Boston transit commission or the city of Boston to construct a subway in or under Cambridge street, Bowdoin square, and Court street to connect with the subway now being constructed by said commission, and shall have made with said commission or city an agreement for the sole use by it of said proposed subway for the running of its trains therein and for other purposes, which shall be for a term of not less than twenty years and at the same rental, and, so far as applicable, shall otherwise contain the same provisions as the lease already made with the West End

Street Railway Company for the use of said subway, said commission shall forthwith construct an incline, open cut, and subway beginning at a point on Cambridge street, near North Russell street, upon, through, and under Cambridge street, Bowdoin square, and Court street to a junction at Scollay square with the subway described in section twenty-five of said chapter five hundred and forty-eight and shall, at the cost and expense of said corporation, to be estimated by the street commissioners of said city and paid in advance into the treasury of said city, such estimated sum to be increased or a part thereof returned, according as the actual expenses are more or less than the sum so estimated, take for the city of Boston such lands on each side of said Cambridge street as may be necessary to make a highway thirty feet wide on each side and extending not less than thirty feet nor more than one hundred feet, as said commissioners may determine, beyond the ends of said open cut, and shall construct such highway: *provided, however*, that in case the transit commissioners of the city of Boston shall determine that said subway may advantageously be extended nearer to Charles river than said North Russell street, said subway shall be so extended and may in such event be constructed under Cambridge street or substantially parallel therewith, and the city of Boston may, by its transit commissioners, take such land and buildings as may be needful for such construction, and the damages occasioned by such taking shall be ascertained and recovered in the manner provided by sections thirty-two and thirty-four of said chapter five hundred and forty-eight. Said takings shall be made, and the damages occasioned to any person by such takings shall be ascertained and recovered, in the manner provided in sections thirty-two and thirty-four of said chapter five hundred and forty-eight.

SECT. 6. Before constructing its railroad upon any route granted to it and before constructing any station in any public way or place said corporation shall prepare and file with the mayor of the city of Boston plans showing the form and method of construction proposed, for his examination and approval as to architectural appearance and obstruction to light and air, who shall approve or disapprove the same in writing, and if disapproved by him the corporation may appeal to the said board of railroad commissioners, who shall determine the question. Said corporation shall also prepare and file with said board plans showing the form and method of construction proposed, and the proposed location of the tracks, elevated structure, and stations, with such detail as may be necessary to show the extent to which any street, way, avenue, bridge, public or private lands are to be encroached upon. Said board shall examine the same with reference to the strength and safety of the structure, and to the strength and safety of any bridge traversed thereby, and with reference to the rolling stock, motive power, and method of operation, and with reference to the convenience and comfort of the public, and may employ, at the expense of said corporation, a competent engineer with whom to consult in relation thereto. When said construction plans are satisfactory to said board they shall give a certificate approving the same. The corporation shall not proceed to construct its road until such certificate has been given, and if said construction plans, as filed, are not satisfactory to said board it may require them to be changed before giving said certificate of approval; and any structure erected in accordance with said plans may be modified or changed by said corporation, with the consent of said board.

SECT. 7. Wherever the routes upon which said corporation is authorized to construct and operate its elevated railroad cross the locations or tracks of any railroad company, the crossing shall be made in such manner and the method of construction shall be such as may be agreed upon between the directors of said railroad company and the directors of said corporation; and if the parties are unable to agree as to the man-

ner of crossing or method of construction at that point, the same shall be determined by the board of railroad commissioners, upon the application of either party. And in case any railroad company sustains any damage by reason of such crossing, or in case any other person or corporation suffers any damage in property, by reason of any acts done by said corporation under the authority of this act or said chapter five hundred and forty-eight, the same shall be estimated and recovered in the manner provided in sections eight, nine, and eleven of said chapter five hundred and forty-eight as amended by this act, according as said sections shall apply. Said corporation may construct that portion of its elevated railroad over that part of the seventh location described in section three of this act between Albany street and Merrimac street in the city of Boston of such strength and character that it will be suitable for the hauling of railroad cars thereon; and said corporation is hereby authorized to haul railroad cars of other corporations thereon; and the restriction contained in section one of said chapter five hundred and forty-eight, as to the transportation of freight and baggage, shall not apply to transportation thereon.

SECT. 8. If, in the construction of its said railroad and appurtenances, it becomes necessary for said corporation to remove any poles, wires, or other structures, in, upon, or over any public streets or ways, or to interfere with any pipes or structures underneath the surface of the ground in such streets or ways, it shall have the right to remove the same: *provided, however*, that it shall at its own expense provide for such structures, either above or below ground, in such manner as the superintendent or other officer having charge of the streets may approve. Said corporation may construct inclines at such points as it may deem expedient, for the purpose of making connections with surface railways or railroads.

SECT. 9. The provisions of chapter forty-nine of the Public Statutes, relative to cases where damages are claimed to estates in which two or more persons have different, separate, or several interests, shall apply to all proceedings under sections eight, nine, and eleven of said chapter five hundred and forty-eight of the acts of the year eighteen hundred and ninety-four in which damages caused by the acts of said corporation are claimed for such estates.

SECT. 10. Said corporation may establish, and take a toll or fare, which shall not exceed the sum of five cents for a single continuous passage in the same general direction upon the roads owned, leased, or operated by it; and this sum shall not be reduced by the legislature during the period of twenty-five years from and after the passage of this act: *provided, however*, that the board of railroad commissioners may upon the petition of the board of aldermen of a city, selectmen of a town, or fifty legal voters of a city or town in which any of the lines owned, leased, or operated by said corporation are located, after due notice and hearing the parties interested, reduce such toll or fare; but such toll or fare shall not, without the consent of said corporation, be so reduced as to yield, with all other earnings and income of said corporation, except the income of the funds deposited with the treasurer of the Commonwealth as required by this act and said chapter five hundred and forty-eight, a net divisible income, after paying all expenses of operation, interest, taxes, rentals, and other lawful charges, and after charging off a reasonable amount for depreciation, of less than eight per cent. per annum on the outstanding capital stock of said corporation actually paid in in cash. The report of the board shall be final and conclusive for one year. During said period of twenty-five years no taxes or excises not at present in fact imposed upon street railways shall be imposed in respect of the lines owned, leased, or operated by said corporation, other than such as may have been in fact imposed upon the lines hereafter leased or operated by it at the date of such operating contract or of such lease or

agreement hereafter made therefor nor any other burden, duty, or obligation which is not at the same time imposed by general law on all street railway companies: *provided, however*, that said corporation shall be annually assessed and shall pay taxes now or hereafter imposed by general law in the same manner as though it were a street railway company, and shall, in addition, as compensation for the privileges herein granted, and for the use and occupation of the public streets, squares, and places, by the lines of elevated and surface railroad owned, leased, and operated by it, pay to the Commonwealth, on or before the last day of November in each year, during said period of twenty-five years, an annual sum, the amount of which shall, in each year ending the last day of September, be determined by the amount of the annual dividend paid in that year by said corporation, in the following manner: — If the annual dividend paid is six per cent. or less, or if no dividend is paid, the sum payable that year shall be a sum equal to seven-eighths of one per cent. of the gross earnings of all the lines of elevated or surface railroads owned, leased, or operated by said corporation; if said dividend exceeds six per cent. then a sum equal to the excess of the dividends over six per cent. in addition to said seven-eighths of one per cent. of said gross earnings. The above sum shall be paid into the treasury of the Commonwealth and distributed among the different cities and towns in proportion to the mileage of elevated and surface main track, reckoned as single track, which is owned, leased, or operated by said corporation and located therein. Said corporation shall also provide free transfer from elevated to surface and from surface to elevated cars at all stations of the elevated lines reached by surface lines and from one elevated car or train to another at junction points entitling a passenger to a continuous ride in the same general direction, and such further free transfers on all the surface lines of railway owned, leased, or operated by it, as may be satisfactory to or required by the board of railroad commissioners.

SECT. 11. Section seventeen of said chapter five hundred and forty-eight is hereby amended by striking out the whole of said section and inserting in place thereof the following: — *Section 17.* Said corporation is hereby authorized, at any time after the passage of this act, to lease and operate the lines, property, rights, locations, and franchises of the West End Street Railway Company, and of any other street railways or elevated railroads whose lines may be or become, in whole or in part, tributary to or connecting with its lines, and enjoy all the rights and privileges thereto appertaining and belonging, subject to the duties, liabilities, and restrictions thereto appertaining; and said West End Street Railway Company, and such railways or railroads, are hereby authorized to make such leases or operating contracts, upon the consent in each case of a majority in interest of their stockholders, given at a meeting called for that purpose: *provided, however*, that no such lease or operating contract of the West End Street Railway Company shall be valid until the terms thereof, so far as they relate to the rental or compensation to be paid, and to the due and safe transportation of the public, have been approved by the board of railroad commissioners; and *provided, further*, that any lease of any other street railway or elevated railroad company shall be subject to the provisions of all general laws relating to the leasing of street railways.

SECT. 12. Said corporation shall not construct, maintain, and operate its railroad in the subway now constructed or in process of construction and now leased to the West End Street Railway Company, unless said street railway company shall, under the provisions of said lease, assign to said corporation its rights, powers, and privileges thereunder, or otherwise consent to such construction, maintenance, or operation; and in such event said corporation may construct and, during the term of the existing and any future contract for the use of the subway, may

operate its railroad in said subway. In such event, upon the request of said corporation and upon its agreement that the cost thereof shall be considered as part of the cost of the subway under the existing contract with said West End Street Railway Company for the use of the same, the Boston transit commission shall make such alterations in the subway, and the approaches thereto, as may be necessary to render the same suitable for the running of cars and trains of cars through the same, in connection with the elevated structure, upon the routes hereinbefore granted, and said commission shall discontinue so much of Travers street as may be necessary to provide a gradual incline from the northerly portion of the subway to the elevated structure on Causeway street. Said transit commission shall also construct the new bridge across the Charles river, now in process of construction by them, of such strength as to safely support said elevated railroad thereon, and shall so design the same that the elevated structure may be placed thereon; but any alteration in the plan and structure of said bridge hereafter made by said commission in order to secure such additional strength shall be paid for by said corporation.

SECT. 13. Said corporation shall, within three months from the passage of this act, deposit with the treasurer of the Commonwealth the sum of three hundred thousand dollars in cash or securities satisfactory to said treasurer, and the same, or any portion thereof remaining after the payment of all executions under the provisions of section thirteen of said chapter five hundred and forty-eight, shall be forfeited to the Commonwealth if said corporation shall negligently fail to perform either of the requirements hereinafter in this section set forth, namely:— Within sixty days from the making of such deposit the corporation shall apply to the board of aldermen of the city of Boston for a route of not less than four or more than seven miles of double track in said city, exclusive of subways, over locations hereinbefore granted. If the route so applied for is not approved by the mayor and aldermen within sixty days of the application therefor, the corporation shall within thirty days from the expiration of said sixty days apply to the board of railroad commissioners for such approval, who shall have authority to approve the same, and upon any refusal or failure for sixty days of any board of aldermen or selectmen to approve any route lawfully applied for by said corporation, the corporation may apply therefor to said board, which may approve the same. The corporation shall construct its railroad over said route first applied for as aforesaid within three years after it is authorized to begin the construction thereof. In case of its failure so to do any lease from the West End Street Railway Company to said corporation shall thereupon cease and determine. If such construction is delayed by litigation or unforeseen casualty, so that the same cannot be completed within said period of three years, the corporation may apply to the supreme judicial court for relief from such forfeiture or determination of said lease, and the court, upon notice to the attorney-general, the city of Boston, and the West End Street Railway Company, and upon hearing and proof that said litigation was not collusive, or that such casualty was without the fault of said corporation, may grant relief against such forfeiture or determination of the lease, and may fix the time within which such construction shall be completed.

SECT. 14. Said corporation shall also, within one year after it is authorized to begin the construction of its railroad over the route first applied for as provided in section thirteen of this act, apply for a further route of such length that the same, with said route first applied for, shall amount to not less than seven miles of double track, exclusive of subways, over locations hereinbefore granted. If said route is not approved by the mayor and aldermen of the city wherein said location is applied for within sixty days of the application therefor, the corporation shall,

within thirty days from the expiration of said sixty days, apply to the board of railroad commissioners for such approval, who shall have authority to approve the same. Said corporation shall construct its railroad over said route within three years after it is authorized to begin the construction thereof.

SECT. 15. Said corporation shall join with the city of Boston and the city of Cambridge in a petition to the legislature for the year eighteen hundred and ninety-eight or the year eighteen hundred and ninety-nine, as said cities may elect, for an act authorizing the construction and maintenance of a bridge across the Charles river, at or near the present site of the West Boston bridge, suitable for the use of the elevated and surface cars of said corporation, and also for all the purposes of ordinary travel between said cities; and said corporation shall pay towards the construction of said bridge such portion thereof as shall be rendered necessary by reason of its being of additional size and strength for the use of the elevated railroad of said corporation, and shall also itself construct or shall pay for constructing its railway, both elevated and surface, across said bridge, and the balance of such cost beyond that paid by said corporation shall be paid one half by the city of Boston and one half by the city of Cambridge. Said corporation shall also, within the period of six months from the time such bridge is finished, apply for a route beginning at any of its lines of elevated track in Boston to said new bridge across the same, to Brattle square in Cambridge, over the locations hereinbefore granted. If said route is not approved by the mayor and aldermen of Boston and Cambridge, within sixty days of the application therefor, the said corporation shall, within thirty days from the expiration of said sixty days, apply to the board of railroad commissioners for such approval, who shall have authority to approve the same. Said corporation shall construct its railroad over said route within two years after it is authorized to begin the construction thereof. The city of Cambridge may petition the supreme judicial court sitting in equity, to enforce compliance with the provisions of this section, and if it be found, on the petition of said city, that said corporation has failed to comply with said provisions, the said supreme judicial court may pass such order or decree as it may deem proper in the premises.

SECT. 16. Section twenty of said chapter five hundred and forty-eight is hereby amended by striking out the whole of said section and inserting in place thereof the following: — *Section 20.* The supreme judicial and superior courts shall have jurisdiction in equity, on petition of any party in interest, or any city or town in which said corporation is required to build a railroad under this act, to compel compliance with the provisions of this act, and to enforce any order made under the authority thereof, and to prevent violation of any provisions thereof, and if it shall be found on complaint of any city or town in which said corporation has built or is proceeding to build a railroad under this act, or of any party in interest, that said corporation has negligently failed to comply with the provisions of this act, the court may pass such order or decree as it may deem proper in the premises: *provided, however,* that no petition in equity shall be filed for damages for which an action is given by this act until payment thereof has been refused on execution issued as provided in section twelve.

SECT. 17. Whenever said corporation is authorized to begin the construction of its railroad over the route first applied for, as provided in section thirteen of this act, the Boston transit commission shall construct a tunnel or tunnels, of sufficient size for two railway tracks, with approaches, entrances, sidings, stations, and connections therefor, and for the running of railway cars therein, from a point on or near Hanover street in the city of Boston, or such other point or points as said board may deem proper for a suitable connection with the subway or subways provided for in section twenty-five of said chapter five hundred and

forty-eight, to a point at or near Maverick square in that part of Boston called East Boston, where a suitable connection with surface tracks may be made. Said tunnel or tunnels shall be constructed in a thorough and substantial manner, with special reference to strength, durability, and safety for railway travel, and shall be water tight, or in case of leakage the water shall be taken care of by said city. Upon completion thereof said commission shall execute a lease thereof in writing to said corporation for a term expiring twenty-five years from the date of the passage of this act, at an annual rental equal to three-eighths of one per cent. of the gross receipts for each year ending September thirtieth, of all lines owned, leased, or operated by said corporation, to be paid to said city on or before the last day of November in each year, with the privilege to the lessee to sublet the same, such lease to contain such other terms and provisions as may be agreed on by said commission and said corporation, or in case of disagreement, as shall be determined by the board of railroad commissioners. Said rental shall be in full compensation for the exclusive use of said tunnel by said corporation, its sub-lessees, successors, or assigns. Said city shall collect from each person passing through said tunnel in either direction a toll of one cent: *provided, however*, that if in any year ending on the thirtieth day of September the receipts from such tolls, together with the rental above provided for, amount to a sum so in excess of the interest and sinking fund requirements of said bonds for that year that the board of railroad commissioners is of the opinion that the toll may be reduced, said board shall on petition of ten citizens of said city establish such reduced toll for the period of one year from the first day of January next ensuing, as will in its opinion yield an amount sufficient to meet, with said rental, said interest and sinking fund requirements for that year; or said board may altogether discontinue such toll when it is of the opinion that such rental alone is sufficient to meet said requirements; but any such reduction shall be carried into effect by provision for the sale of tickets, and the cash fare shall continue to be one cent. The whole amount of such tolls and of said rentals is hereby pledged to meet the principal and interest of the bonds issued to pay for the construction of said tunnel or tunnels, and this pledge shall be expressed on the face of such bonds as one of the terms thereof: *provided, however*, that after such tolls have been discontinued if said rentals shall for any year ending on the thirtieth day of September yield an amount more than sufficient to meet the interest and sinking fund requirements of said bonds for such year such excess over said requirements shall be regarded as general revenue of said city. In case in any year the rentals and tolls above provided for shall not yield a sufficient amount to meet said interest and sinking fund requirements the compensation received by said city under section ten of this act shall be applied so far as may be necessary toward meeting such requirements. Said corporation shall be the agent of said city to collect such tolls, under such arrangements as shall be agreed upon by said city and said corporation, or in case of disagreement, as shall be determined by the board of railroad commissioners.

SECT. 18. The treasurer of said city shall from time to time, on the request of said transit commission, issue and sell at public or private sale, bonds of said city to the amount required to pay the cost and expenses of constructing the incline, open cut, and subway under Cambridge street, Bowdoin square, and Court street provided for in section five of this act, and the stations, steps, and other structures in connection therewith, and of any alterations in subways which may be required under the lease of the subway made by said commission with said West End Street Railway Company, and shall further issue bonds for the purposes hereinafter specified to the amount of five hundred thousand dollars; all of said bonds shall be designated on their face, Rapid Transit Loan, shall be for the term of forty years, and be registered or have

coupons attached, and shall bear interest at a rate not exceeding four per cent. per annum, payable semi-annually, as said treasurer shall determine, and shall not be included in determining the limit of indebtedness of said city; said treasurer shall apply the proceeds of said five hundred thousand dollars in bonds, and the proceeds of the seven millions of dollars in bonds authorized to be issued by said chapter five hundred and forty-eight, to the payment of the costs and expenses of constructing the subways authorized by section twenty-five of said chapter five hundred and forty-eight, and of the tunnel or tunnels to East Boston provided for in the preceding section, and the stations, inclines, and steps in connection therewith, but a separate account shall be kept of the bonds issued for, and expenses incurred in connection with, the construction of said tunnel or tunnels.

SECT. 19. The locations of or right to maintain any elevated lines or structures of the Boston Elevated Railway Company shall not be subject to revocation except in the manner and on the terms prescribed in sections seven and eight of chapter one hundred and twelve of the Public Statutes: *provided, however*, that any location upon which said corporation has not constructed its railroad within ten years from the passage of this act shall be subject to revocation by the legislature; but no location upon which said corporation has begun the construction of its railroad within said period shall be subject to revocation if the same be completed within three years thereafter.

SECT. 20. Section ten of said chapter five hundred and forty-eight of the acts of the year eighteen hundred and ninety-four is hereby amended so as to read as follows:—*Section 10.* Said corporation may locate stations at convenient points, with suitable exits and approaches to and from the streets and stations, but the same, excepting platforms and approaches thereto from buildings, shall not be located in any public way or place, unless approved by the mayor and aldermen or selectmen.

SECT. 21. Except as otherwise expressly provided in said chapter five hundred and forty-eight and by this act, said corporation shall have all the powers and privileges and be subject to all the duties, liabilities, and restrictions set forth in general laws now or hereafter in force relating to street railway companies, so far as the same may be applicable, but the provisions of chapter one hundred and thirteen of the Public Statutes or other general laws relating to the alteration or revocation of locations of street railway companies, shall not be deemed applicable to the locations or routes for elevated railroads granted to said corporation. So much of section one of said chapter five hundred and forty-eight as provides that said corporation shall be subject to the general laws relating to railroad corporations is hereby repealed.

SECT. 22. Sections sixteen, nineteen, and twenty-one of said chapter five hundred and forty-eight are hereby repealed.

SECT. 23. This act shall take effect upon its passage. [*Chap. 500, Acts of 1897.*]

APPENDIX D.

STATISTICS OF SURFACE TRAFFIC, MAY 7, 8, AND 10, 1897.
LENGTH OF TRIPS, SOUTH-BOUND CARS, 1897.

THIRD ANNUAL REPORT.

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Trips.	Winter to Church st.			Winter to Tremont at Pleasant st.			Winter to Shawmut ave. at Pleasant st.			Shawmut ave. at Pleasant st. to Dudley st.			Winter to Dudley st.		
	May 7.	May 8.	May 10.	May 7.	May 8.	May 10.	May 7.	May 8.	May 10.	May 7.	May 8.	May 10.	May 7.	May 8.	May 10.
Quickest.	3.40	3.26	3.26	3.10	2.55	2.55	3.10	3.13	3.13	7.40	6.59	6.59	14.15	11.53	11.53
Slowest	9.45	8.47	9.45	10.00	7.50	10.00	10.00	10.16	10.16	14.58	13.50	14.58	19.20	20.25	20.25
Average	5.58	5.43	5.51	6.02	4.49	5.26	6.02	5.50	5.53	10.28	10.35	10.32	16.19	16.26	16.23
Quickest.	3.44	4.57	3.44	2.55	4.55	2.55	2.55	4.33	3.59	8.35	9.07	8.35	14.15	15.05	14.15
Slowest	8.32	8.20	8.32	8.15	8.10	8.15	8.15	9.07	9.07	15.38	14.50	15.38	18.54	22.00	22.00
Average	6.17	6.23	6.20	6.13	6.08	6.11	6.13	6.51	6.19	10.56	11.15	11.06	16.42	18.05	17.24
Quickest.	5.21	5.00	5.00	5.10	4.30	4.30	5.10	4.45	2.35	7.28	7.47	7.28	16.16	15.05	15.05
Slowest	11.59	9.45	11.59	9.42	10.00	10.00	9.42	10.00	10.04	17.48	14.30	17.48	23.00	23.35	23.35
Average	7.52	7.03	7.28	7.18	7.00	7.09	7.18	7.10	7.15	11.23	11.22	11.23	18.42	18.29	18.36
Quickest.	3.41	4.38	3.41	2.45	3.45	2.45	2.45	4.43	3.58	7.59	8.15	7.59	13.25	15.18	13.25
Slowest	8.11	9.01	9.01	8.10	8.42	8.42	8.10	9.05	9.58	14.14	18.00	18.00	19.36	23.20	23.20
Average	5.14	6.16	5.45	5.23	6.01	5.42	5.23	6.23	6.08	10.46	11.42	11.14	16.34	18.13	17.24
Quickest.	3.40	3.26	3.26	2.45	2.55	2.45	2.45	3.13	2.35	7.23	6.59	6.59	13.25	11.53	11.53
Slowest	11.59	9.45	11.59	10.00	10.00	10.00	10.00	10.16	10.16	17.48	18.00	18.00	23.00	23.35	23.35
Average	6.29	6.18	6.24	6.14	6.04	6.07	6.17	6.36	6.27	10.55	11.16	11.06	17.10	17.52	17.31
Quickest.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	15.40
Slowest	..	..	..	..	..	..	..	..	..	..	..	..	..	..	25.50
Average	..	..	..	..	..	..	..	..	..	..	..	..	..	..	19.36

10 A.M. 6-10 A.M. 10 A.M. 1-6 P.M. 6-12 P.M. 6-12 P.M. 6-12 P.M. 6 A.M. to 12 P.M. 6-8 P.M. to 12 P.M.

LENGTH OF TRIPS, NORTH-BOUND CARS, 1897.

TRIPS.	Church to Winter st.				Tremont at Pleasant to Winter st.				Shawmut ave. at Pleasant to Winter st.				Dudley st. to Shawmut ave. at Pleasant st.				Dudley to Winter st.			
	May 7.	May 8.	May 7 and 8.	May 10.	May 7.	May 8.	May 7 and 8.	May 10.	May 7.	May 8.	May 7 and 8.	May 10.	May 7.	May 8.	May 7 and 8.	May 10.	May 7.	May 8.	May 7 and 8.	May 10.
Quickest	2.47	3.15	2.47	. . .	3.00	4.10	3.00	. . .	3.30	2.30	2.30	. . .	8.45	7.51	7.51	. . .	13.40	13.17	13.17	May 10.
Slowest	11.00	9.05	11.00	. . .	10.40	13.55	13.55	. . .	7.50	8.39	8.39	. . .	14.10	16.22	16.22	. . .	21.30	21.02	21.30	May 7
Average	6.05	6.22	6.14	. . .	5.29	6.33	6.01	. . .	5.31	5.34	5.33	. . .	11.48	11.41	11.44	. . .	17.19	17.14	17.17	May 8.
Quickest	3.50	4.10	3.50	. . .	4.25	3.45	3.45	. . .	5.54	2.30	2.30	. . .	8.45	7.35	7.35	. . .	16.40	12.00	12.00	May 7.
Slowest	9.30	8.35	9.30	. . .	8.15	10.30	10.30	. . .	8.52	8.55	8.55	. . .	13.35	14.30	14.30	. . .	20.40	19.35	20.40	May 10.
Average	6.52	5.54	6.23	. . .	6.32	5.51	6.12	. . .	7.16	4.48	6.02	. . .	11.37	11.09	11.23	. . .	18.26	15.51	17.09	May 8.
Quickest	4.25	5.00	4.25	. . .	4.26	4.48	4.26	. . .	4.00	3.29	3.29	. . .	8.48	9.29	8.48	. . .	14.05	14.45	14.05	May 7.
Slowest	12.20	12.23	12.23	. . .	8.46	11.10	11.10	. . .	8.44	10.49	10.49	. . .	14.08	15.41	15.41	. . .	20.35	25.55	25.55	May 10.
Average	7.17	7.56	7.37	. . .	6.33	7.22	6.58	. . .	6.13	6.39	6.26	. . .	11.13	12.07	11.40	. . .	17.28	18.53	18.10	May 8.
Quickest	2.40	3.24	2.40	. . .	2.50	3.25	2.50	. . .	2.52	3.00	2.52	. . .	9.49	8.15	8.15	. . .	14.40	13.20	13.20	May 7.
Slowest	8.05	9.25	9.25	. . .	7.45	8.30	8.30	. . .	6.55	7.40	7.40	. . .	16.08	15.40	16.08	. . .	21.50	20.00	21.50	May 10.
Average	5.09	5.35	5.22	. . .	5.13	5.42	5.28	. . .	4.45	4.59	4.52	. . .	12.04	11.53	11.59	. . .	16.49	16.58	16.54	May 8.
Quickest	2.40	3.15	2.40	. . .	2.50	3.25	2.50	. . .	2.52	2.30	2.30	. . .	8.45	7.35	7.35	. . .	13.40	12.00	12.00	May 7.
Slowest	12.20	12.23	12.23	. . .	10.40	13.55	13.55	. . .	8.52	10.49	10.49	. . .	16.08	16.22	16.22	. . .	21.50	25.55	25.55	May 10.
Average	6.18	6.40	6.29	. . .	5.52	6.34	6.13	. . .	5.41	5.38	5.40	. . .	11.40	11.46	11.43	. . .	17.19	17.26	17.23	May 8.
Quickest	. . .	. . .	. . .	3.30	. . .	. . .	. . .	4.15	. . .	. . .	. . .	3.40	. . .	. . .	. . .	8.53	. . .	. . .	13.40	
Slowest	. . .	. . .	. . .	9.38	. . .	. . .	. . .	7.59	. . .	. . .	. . .	7.29	. . .	. . .	. . .	15.00	. . .	. . .	21.30	
Average	. . .	. . .	. . .	6.27	. . .	. . .	. . .	6.08	. . .	. . .	. . .	5.50	. . .	. . .	. . .	11.40	. . .	. . .	17.39	

10 A.M. to 1 P.M.

1-6 P.M.

6-12 P.M.

6 A.M. to 12 P.M.

5-8 P.M.

LENGTH OF TRIPS, SOUTH-BOUND CARS, 1897.

TRIPS.		WINTER AND WINTER VIA TREMONT HOUSE.			WINTER AND WINTER VIA UNION STATION.		
		7.	8.	10.	7.	8.	10.
		May	May	May	May	May	May
6 A.M. to 10 A.M.	Quickest	1.20	1.05		16.10	15.30	
	Slowest	8.10	8.30		29.15	34.50	
	Average	3.12	3.15		22.04	23.17	
10 A.M. to 1 P.M.	Quickest	1.00	1.15		19.58	19.35	
	Slowest	5.38	8.05		27.05	28.55	
	Average	2.45	3.57		23.03	28.50	
1 P.M. to 6 P.M.	Quickest	1.02	1.07		15.35	19.45	
	Slowest	10.18	10.25		30.45	31.43	
	Average	3.24	3.58		23.52	25.43	
6 P.M. to 12 P.M.	Quickest	1.00	1.05		13.38	14.50	
	Slowest	9.50	8.02		27.00	31.30	
	Average	4.01	3.40		18.33	19.15	
6 A.M. to 12 P.M.	Quickest	1.00	1.05		13.38	14.50	
	Slowest	10.18	10.25		30.45	34.50	
	Average	3.29	3.43		21.47	23.14	
5 P.M. to *8 P.M.	Quickest			1.00			14.15
	Slowest			7.25			30.40
	Average			3.08			20.43

* Sudden squall and shower at 5.30 P.M. and heavy rain until 8 P.M.

NUMBER OF CARS SOUTH-BOUND, 1897.

Hours.	Winter st.		Church st.		Tremont st. at Pleasant st.		Shawmut ave. at Pleasant st.	
	May 7.†	May 8.	May 7.	May 8.	May 7.	May 8.**	May 7.	May 8.
6 to 7 A.M.	70*	71*	34*	36*	27	28	8*	7*
7 to 8	119	125	69	67	38	39	15	17
8 to 9	176	165	120	113	42	42	16	16
9 to 10	177	162	119	129	45	46	13	15
For the four hours	542	523	342	345	152	155	52	55
10 to 11 A.M.	149	151	105	101	35	34	18	18
11 to 12	146	154	115	111	35	34	19†	16
12 to 1 P.M.	142	145	97	103	33	32	13	18
For the three hours	437	450	317	315	103	100	50	52
1 to 2 P.M.	132	147	104	104	32	34	19†	15
2 to 3	158	181	101	110	38	52	15	16
3 to 4	172	160	112	115	40	34	17	16
4 to 5	173	165	134	128	41	36	19†	16
5 to 6	175	180	135†	138†	56†	60	16	19†
For the five hours	810	833	586	595	207	216	86	82
6 to 7 P.M.	178†	192†	131	135	51	61†	17	14
7 to 8	139	149	105	104	40	36	10	13
8 to 9	144	150	91	97	32	35	12	12
9 to 10	119	127	79	81	26	27	12	12
10 to 11	132	129	83	86	26	29	14	12
11 to 12	91	100	66	68	25*	25*	11	13
For the six hours	803	847	555	571	200	213	76	76
For eighteen hours	2,592	2,653	1,800	1,826	662	684	264	255

* Minimum in an hour.

† Maximum in an hour.

** Baseball to-day.

† Largest number of cars passing in a minute, 9; namely, between 5 and 6 P.M.

May 7. Maximum number in an hour, south-bound, 178; Winter st., from 6 to 7 P.M.

May 8. Maximum number in an hour, south-bound, 192; Winter st., from 6 to 7 P.M.

NUMBER OF CARS NORTH-BOUND, 1897.

HOURS.	Winter st.		Church st.		Tremont st. at Pleasant st.		Shawmut ave. at Pleasant st.	
	May 7.**†		May 7.‡		May 7.		May 7.	
	May 8.	May 8.	May 8.	May 8.	May 8.	May 8.	May 8.	May 8.
6 to 7 A.M.	95	98	45*	47	38	37	12	12
7 to 8	152	153	87	90	43	42	17	17
8 to 9	213†	206†	136	121	51	48	20†	16
9 to 10	173	170	116	114	35	39	15	15
For the four hours	633	627	384	372	167	166	64	60
10 to 11 A.M.	160	170	106	109	35	30	16	17
11 to 12	180	165	85	104	35	36	16	16
12 to 1 P.M.	139	155	96	102	33	34	12	15
For the three hours	479	490	287	315	103	100	46	48
1 to 2 P.M.	161	166	103	111	31	46	18	15
2 to 3	176	188	109	114	48	47	16	18†
3 to 4	171	168	115	115	38	39	16	15
4 to 5	185	180	135	138	36	45	15	16
5 to 6	203	206†	143†	143†	66†	66†	18	16
For the five hours	896	908	605	621	219	243	83	80
6 to 7 P.M.	166	185	105	100	33	35	13	14
7 to 8	183	197	104	117	35	40	13	12
8 to 9	168	164	86	86	31	28	11	12
9 to 10	141	147	84	85	26	25	12	12
10 to 11	162	170	79	84	33	33	15	11
11 to 12	62*	67*	45*	45*	17*	17*	7*	8*
For the six hours	882	930	503	516	175	178	71	70
For eighteen hours	2,880	2,955	1,779	1,824	664	687	264	258

* Minimum in an hour.

† Maximum in an hour.

‡ Largest number of cars passing in a minute, 7.

§ Largest number of cars in a minute, 6.

** Largest average per minute throughout a full hour, 3.55.

May 7. Maximum number in an hour, north-bound, 213; Winter st., from 8 to 9 A.M.

May 8. Maximum number in an hour, north-bound, 208; Winter st., from 5 to 6 P.M.

May 8. Maximum number in an hour, north-bound, 208; Winter st., from 8 to 9 A.M.

APPENDIX E.

APPROVAL BY THE BOARD OF HARBOR AND
LAND COMMISSIONERS OF THE PIER PLANS,
CHARLESTOWN BRIDGE.

COMMONWEALTH OF MASSACHUSETTS.



No. 1957.

Whereas, The Boston Transit Commission of Boston, in the County of Suffolk and Commonwealth aforesaid, has been authorized and required by the General Court, by chapter 548 of the Acts of the year 1894, to construct a bridge over Charles river between the present Charles-river bridge and the Fitchburg Railroad bridge, in the city of Boston, in the County of Suffolk, and Commonwealth aforesaid; and, before beginning the construction of the piers of said bridge, has given written notice to the Board of Harbor and Land Commissioners of the work intended to be done, and submitted, for the approval of said Board, plans showing in detail the location and dimensions of said work, and the mode in which the same is to be performed; and whereas due notice of said application, and of the time and place fixed for a hearing thereon, has been given, as required by law, to the Mayor and Aldermen of the city of Boston;

Now, said Board, having heard all parties desiring to be heard, and having fully considered said application, hereby approves the plans and specifications for said work hereto annexed, and the mode of performing the same as shown thereby, and, subject to the approval of the Governor and Council, hereby authorizes and licenses said work to be done in accordance therewith, subject to the provisions of the nineteenth chapter of the Public Statutes, and of all laws which are or may be in force applicable thereto.

The plans hereby approved are required by the terms of license No. 1859, granted by this Board Nov. 25, 1895.

A duplicate of the aforesaid plan numbered 1957 remains on file in the office of said Board, and said work is to be executed under its supervision.

Nothing herein contained shall be so construed as to impair the legal rights of any person.

This license shall be void unless the same and the accompanying plans are recorded, within one year from the date hereof, in the Registry of Deeds for the County of Suffolk.

IN WITNESS WHEREOF The said Harbor and Land Commissioners have hereto set their hands this eighth day of September in the year eighteen hundred and ninety-six.

(Signed) WOODWARD EMERY, } *Harbor and Land*
 CHARLES H. HOWLAND, } *Commissioners.*

COMMONWEALTH OF MASSACHUSETTS.

BOSTON, Sept. 10, 1896.

Approved by the Governor and Council.

(Signed) E. F. HAMLIN,
Executive Clerk.

APPENDIX F.

CEMENT DURING YEAR ENDING AUGUST 15, 1897.

Approximate number of barrels of cement used (mostly German, but partly of American manufacture).	150,000
Approximate number of barrels of Rosendale cement used	3,000
Approximate number of briquettes made (briquettes made from sample cement and also daily of mortar from the boxes of the contractors, broken at various ages, from one week to two or more years, the larger proportion when a week old)	12,000
Approximate number of concrete beams made (six inches square and 6 feet long, some kept in tanks and some in damp sand, mostly broken when 30 days old)	300

The remarks in last year's report as to manner of testing, sand, etc., are true for the present year.

APPENDIX G.

SURFACE AND UNDERGROUND WORK DURING THE YEAR ENDING AUGUST 15, 1897, IN FINISHING SECTIONS 1, 2, AND 3 OF THE SUBWAY.

(*Direct Work and Contract.*)

Direct Work.—Grading, seeding, and fencing of loam areas adjoining the walks. Laying subsoil drains. Construction of tar concrete and gravel walks. Insertion of skylights in the subway roof at the surface level. Cement washing and painting of the subway walls where not otherwise treated.

Artificial Stone Walks and Platforms.—Work divided between Manhattan Concrete Company, of New York, and Simpson Brothers Corporation, of Boston. Specifications called for base course 4 inches thick, of Portland concrete, as used in subway structure, and wearing surface 1 inch thick of Portland cement mortar. Accepted prices for this work, including all materials and labor, range from \$1.42 to \$1.54 per square yard.

Glazed Brick and Tile Surfaces and Encasing Platforms.—Contract awarded to Boston Fire Brick & Clay Retort Manufacturing Company and the Grueby Faience Company jointly, for supplying and fixing lining of enamelled tile on interior walls of Park-street station. Specifications called for white enamelled tile measuring 9 inches $\times$ 4½ inches $\times$ 1½ inches, laid in Portland cement mortar against brickwork backing nowhere less than 4 inches thick and about a foot thick in centre of curved panels between steel columns. Contract price for all materials and labor necessary for whole work, \$5,425 per square yard. At Boylston-street station contract was awarded to Norcross Brothers, enamelled brick. Contract price same as at Park street.

Progress on Direct and Contract Work.

ITEMS.	Date of beginning.	Date of completing.	Total amount of work done, year ending Aug. 15, 1897.
	1897	1897	
Subsoil drains	April 1	August 10	2,738 lin. ft.
Granolithic walks	May 18	August 7	7,941 sq. yds.
Tar-concrete walks	May 27	August 1	945 " "
Gravel walks	April 19	August 10	4,065 " "
Street sidewalks changed			200 " "
Loam areas	April 1	August 1	10,700 " "
Fencing	May 8	July 14	5,463 lin. ft.
Skylights	May 13	August 15	81 (No.)
Encasing platform columns	May 17	June 21	196 (No.)
Cement washing	Sept. 29, 1896	May 13	19,730 sq. yds.
Painting interior	April 27	July 21	38,475 " "
Glazed tile on walls	Feb. 1	May 10	1,081 " "
Enamelled brick on walls	Feb. 1	May 10	1,400 " "
Granolithic platforms	May 22	June 19	3,720 " "

APPENDIX H.

DISPOSITION OF SURPLUS EARTH FROM SUBWAY SECTIONS DURING
THE YEAR ENDING AUGUST 15, 1897.

Number of section.	Cubic yards.	Where taken.
1, 2	{ 36,000	To Common { 1,140 placed underneath platforms, Sec. 2. { 1,360 " " " " 3.
	 5,555	Either sold by Contractor or used by Commission.
3	{ 5,110	To Cambridge.
	800	" Boston Common.
4		" Sections 4 and 5.
5	{ 3,842	Some used in grading streets on Back Bay, but most
	714	went to new Union Station.
	About 4,000	To Cambridge Park Department.
6	{ 22,000	" Russia wharf.
		To Cambridge.
		" cars.
		" Russia wharf.
		" Section 4.
		" " 8.
		" Winslow wharf.
7	{ 12,430	To Cambridge Park Department.
	8,300	" cars.
8	{ 10,151	" new Union Station.
	820	" cars.
8½	{ 8,294	" cars.
	1,813	" Cambridge Park Department.
9	{ 2,264	" Cambridge Park Department.
	20,833	" cars.
	290	" Russia wharf.
10	{ 6,760	" Cambridge Park Department.
	25,126	" cars.

APPENDIX J.

CANVASS OF BIDS FOR STEEL, SECTION 7, SUBWAY,
APRIL 7, 1897.

BIDDERS AND ADDRESSES.	580 tons of steel.	Totals.
Passaic Rolling Mill Company, Paterson, N.J.....	\$49 25	\$28,565 00
New Jersey Steel & Iron Company, Trenton, N.J. .	48 40	28,072 00
Boston Bridge Works, Boston, Mass.....	48 35	28,043 00
Thomas Marshall, Pittsburgh, Pa.....	47 20	27,376 00
A. & P. Roberts Co., Phila., Pa.	47 20	27,376 00
The Carnegie Steel Company, L't'd, Pittsburgh, Pa.,	43 86	25,438 80

APPENDIX K.

CANVASS OF BIDS, MAY 12, 1897. — SECTION 7, SUBWAY.

BIDDERS AND ADDRESSES.	a	c	d	ee	f	ff	j	p	b	t	Totals.
George W. Judd, Boston, Mass.	\$3 50	\$0 50	\$12 50	\$17 82	\$6 75	\$9 75	\$25 00	\$1 25	\$0 50	\$0 50	\$140,515 20
	75,950 00	200 00	7,250 00	6,415 20	675 00	38,025 00	1,750 00	1,250 00	4,500 00	4,500 00	
E. W. Everson & Co., Boston, Mass.	2 25	1 00	15 00	17 00	7 00	9 00	30 00	0 75	0 40	0 30	108,395 00
	48,825 00	400 00	8,700 00	€120 00	700 00	35,100 00	1,500 00	750 00	3,600 00	2,700 00	
National Contracting Co., New York, N.Y.	2 15	1 25	10 00	16 00	6 50	9 15	30 00	1 20	0 40	0 40	104,950 00
	46,655 00	500 00	5,800 00	5,760 00	650 00	35,685 00	1,500 00	1,200 00	3,600 00	3,600 00	
Shaller & Schniglan Co., Chicago, Ill.	2 00	1 00	10 00	16 50	7 00	9 00	30 00	1 00	0 35	0 30	99,690 00
	43,400 00	400 00	5,800 00	5,940 00	700 00	35,100 00	1,500 00	1,000 00	3,150 00	2,700 00	

APPENDIX L.

CANVASS OF BIDS FOR STEEL, SECTION 8, SUBWAY, SEPTEMBER 15, 1896.

BIDDERS AND ADDRESSES.	310 tons steel.	Totals.
Boston Bridge Works, Boston, Mass.....	\$59 90	\$18,569 00
New Jersey Steel and Iron Company, Trenton, N.J.,	49 80	15,438 00
Pennsylvania Steel Company, Steelton, Pa.	49 70	15,407 00
Carnegie Steel Company, L't'd, Pittsburgh, Pa.....	44 80	13,888 00
A. & P. Roberts Co., Philadelphia, Pa.	41 98	13,013 80

APPENDIX M.

CANVASS OF BIDS, SECTION 8, SUBWAY, OCTOBER 6, 1896.

BIDDERS AND ADDRESSES.	a	c	d	ee	f	ff	p	g	t	TOTALS.
	14,000 cu. yds. of earth excavation.	900 lin. ft. laying 6, 8, 10, 12 in. sewer pipe.	310 tons of iron and steel work set in place and secured.	200 cu. yds. of brick cement mas., Port.	100 cu. yds. concrete mas., Ros. cement mortar.	2,600 cu. yds. of concrete mas., Port. cement mortar.	850 sq. yds. for outside of subway walls.	5,000 sq. yds. of plastering of Port. cement mortar.	6,000 sq. yds. of water-proof coating.	
Aab & Co., Waltham, Mass.	\$6 50 91,000 00	\$0 50 450 00	\$15 00 4,850 00	\$15 00 3,000 00	\$9 00 900 00	\$10 00 26,000 00	\$1 20 1,020 00	\$0 50 2,500 00	\$0 50 3,000 00	\$132,520 00
E. W. Everson, Providence, R.I.	2 35 32,900 00	1 00 900 00	12 00 3,720 00	16 00 3,200 00	7 00 700 00	8 75 22,750 00	1 00 850 00	0 50 2,500 00	0 40 2,400 00	69,920 00
S. W. Frescoln, Reading, Pa.	2 50 35,000 00	0 30 270 00	9 00 2,790 00	16 00 3,200 00	6 50 650 00	8 25 21,450 00	1 00 850 00	0 40 2,000 00	0 45 2,700 00	68,910 00
Shailer & Schnigian Co., Chicago, Ill.	2 50 35,000 00	0 50 450 00	7 50 2,325 00	14 50 2,900 00	7 00 700 00	8 75 22,750 00	0 85 722 50	0 30 1,500 00	0 25 1,500 00	67,847 50
Barber Asphalt Paving Co., Boston, Mass.	1 95 27,300 00	0 40 360 00	9 25 2,867 50	15 75 3,150 00	6 50 650 00	8 75 22,750 00	1 50 1,275 00	0 40 2,000 00	0 40 2,400 00	62,752 50
Metropolitan Construction Co., Boston, Mass.	1 95 27,300 00	0 70 630 00	9 00 2,790 00	16 75 3,350 00	6 00 600 00	8 50 22,100 00	1 00 850 00	0 40 2,000 00	0 30 1,800 00	61,420 00

APPENDIX N.

CANVASS OF BIDS FOR STEEL, SECTION 8½, SUBWAY, MARCH 1, 1897.

BIDDERS AND ADDRESSES.	260 tons steel.	Totals.
New Jersey Steel and Iron Company, Trenton, N.J.,	\$51 20	\$13,312 00
The Pennsylvania Steel Company, Steelton, Pa....	50 80	13,208 00
The Carnegie Steel Company, L't'd, Pittsburgh, Pa.,	47 33	12,305 80
David H. Andrews, Newton, Mass.....	46 14	11,996 40
A. & P. Roberts Co., Philadelphia, Pa.	44 00	11,440 00

APPENDIX O.

CANVASS OF BIDS, SECTION 84, SUBWAY, MARCH 31, 1897.

BIDDERS AND ADDRESSES.	Totals.									
	a	c	d	ee	f	ff	p	h	t	
	10,500 cu. yds. of earth excavation.	200 linear ft. of 12-in. vitrified sewer-pipe.	260 tons of iron and steel work set in place and secured.	160 cu. yds. of brick masonry, Portland cement mortar.	100 cu. yds. of concrete masonry, Rosendale cement mortar.	2,200 cu. yds. of concrete masonry, Portland cement mortar.	1,000 sq. yds. of lining for outside of walls.	5,000 sq. yds. of plastering of Portland cement mortar.	5,000 sq. yds. of water-proof coating.	TOTALS.
O. H. Eglee Company, 53 State st., Boston, Mass.	\$2 75 28,875 00	\$0 50 100 00	\$8 50 2,210 00	\$17 25 2,760 00	\$6 00 600 00	\$9 90 21,780 00	\$1 00 1,000 00	\$0 40 2,000 00	\$0 30 1,500 00	\$60,825 00
W. H. Keyes & Co., 17 Otis st., Boston, Mass.	2 60 27,300 00	0 50 100 00	10 00 2,600 00	16 50 2,640 00	7 00 700 00	9 50 20,900 00	1 50 1,500 00	0 50 2,500 00	0 40 2,000 00	60,240 00
Richardson & Young, 94 La Salle st., Chicago, Ill.	2 10 22,050 00	2 00 400 00	10 00 2,600 00	14 00 2,240 00	6 25 625 00	9 50 20,900 00	1 00 1,000 00	0 38 1,900 00	0 30 1,500 00	53,215 00
The National Contracting Company, New York, N.Y.	1 90 19,950 00	1 00 200 00	9 50 2,470 00	16 00 2,450 00	6 50 650 00	8 50 13,700 00	1 20 1,200 00	0 40 2,000 00	0 40 2,000 00	49,730 00

APPENDIX P.

CANVASS OF BIDS FOR STEEL—PART OF SECTION 9,
SUBWAY, OCTOBER 15, 1896.

BIDDERS AND ADDRESSES.	192 STEEL POSTS (ABOUT 100 TONS).	
	Price per ton.	Amount for 100 tons.
New Jersey Steel and Iron Company, Trenton, N.J. . . .	\$66 20	\$6,620 00
Carnegie Steel Company, Pittsburgh, Pa.	65 00	6,500 00
Edge Moor Bridge Company, Wilmington, Del.	58 00	5,800 00
Pennsylvania Steel Company, Steelton, Pa.	54 90	5,490 00
Passaic Rolling Mill Company, Paterson, N.J.	49 60	4,960 00
A. & P. Roberts Company, Pencoyd Iron Works, Philadelphia, Pa.	49 00	4,900 00

APPENDIX Q.

CANVASS OF BIDS FOR STEEL, SECTION 9, SUBWAY,
JANUARY 11, 1897.

BIDDERS AND ADDRESSES.	750 TONS.	
	Price per ton.	Totals.
Carnegie Steel Company, L't'd, Pittsburgh, Pa.....	\$59 00	\$44,250 00
Pennsylvania Steel Company, Steelton, Pa.	55 00	41,250 00
New Jersey Steel & Iron Company, Trenton, N.J. .	48 20	36,150 00
Passaic Rolling Mill Company, Paterson, N.J.....	45 98	34,485 00
A. & P. Roberts Co., Pencoyd Iron W'ks, Phila., Pa.,	44 54	33,405 00

APPENDIX R.

CANVASS OF BIDS, SECTION 9, SUBWAY, FEBRUARY 24, 1897.

BIDDERS AND ADDRESSES.	8,000 cu. yds. of earth excavation.	15,000 cu. yds. of earth excavation, including 5,000 cu. yds. of concrete.	500 tons of iron and steel work set in place and secured.	540 cu. yds. of brick masonry, including 100 cu. yds. of concrete masonry.	100 cu. yds. of concrete masonry, including 100 cu. yds. of concrete masonry.	3,000 cu. yds. of concrete masonry, including 100 cu. yds. of concrete masonry.	30 cu. yds. of granite looking-slates.	750 sq. yds. of tiling for outside walls.	14,000 cu. yds. of Portland cement mortar.	10,000 sq. yds. of waterproof coating.	TOTALS.
	<i>a</i>	<i>aa</i>	<i>d</i>	<i>ee</i>	<i>f</i>	<i>ff</i>	<i>j</i>	<i>p</i>	<i>q</i>	<i>t</i>	
Metropolitan Construction Company, Boston, Mass. {	\$4 25 34,000 00	\$2 75 44,000 00	\$13 50 6,930 00	\$18 50 9,990 00	\$7 00 700 00	\$10 25 39,975 00	\$36 00 1,050 00	\$1 25 937 50	\$0 50 7,000 00	\$0 50 6,000 00	\$149,612 00
The C. H. Eglee Co., 53 State st., Boston, Mass. {	2 93 23,410 00	2 13 34,080 00	16 00 10,560 00	21 30 11,502 00	8 00 600 00	11 33 44,187 00	25 00 750 00	1 25 937 50	0 54 7,660 00	0 52 5,200 00	
W. H. Keyes & Co., Boston, Mass. {	2 60 29,800 00	2 60 41,600 00	10 00 6,600 00	16 50 8,910 00	7 00 700 00	9 30 36,270 00	30 00 900 00	2 00 1,500 00	0 50 7,000 00	0 35 3,500 00	127,780 00
Shaller & Schniglaui Co., Chicago, Ill. {	3 50 28,000 00	1 29 19,200 00	12 00 7,920 00	17 00 9,180 00	7 50 750 00	9 50 37,050 00	25 00 750 00	1 00 750 00	0 50 7,000 00	0 30 3,000 00	
The National Contracting Company, New York, N.Y. {	2 45 19,600 00	1 77 28,320 00	10 25 6,765 00	15 75 8,505 00	8 00 800 00	8 50 33,150 00	33 00 900 00	1 29 900 00	0 40 5,600 00	0 40 4,000 00	108,490 00
McArthur Bros. Co., Chicago, Ill. {	2 45 19,600 00	1 15 18,400 00	11 50 7,590 00	13 50 7,280 00	5 50 650 00	8 45 32,555 00	30 00 900 00	0 40 300 00	0 36 5,040 00	0 20 2,000 00	
Richardson & Young, 94 La Salle st., Chicago, Ill. {	1 68 13,410 00	1 68 26,880 00	7 50 4,950 00	14 00 7,560 00	5 10 610 00	8 00 31,200 00	30 00 900 00	1 00 750 00	0 38 5,320 00	0 30 3,000 00	94,610 00
E. W. Everson & Co., Boston, Mass. {	4 00 32,000 00	0 30 4,800 00	10 00 6,000 00	15 00 8,640 00	7 09 700 00	8 00 31,200 00	20 00 600 00	0 60 875 00	0 40 5,000 00	0 30 3,000 00	

NOTE. — Items *a* and *aa* are liable to change. See pages 9 and 10 of Bid.

IF		TOTAL BID.	
<i>a</i> becomes	<i>aa</i> becomes	E. W. Everson.	Richardson & Young.
8,300	15,700	\$94,825	\$94,610
14,000	10,000	115,715	94,610
24,000	0	152,715	94,610

APPENDIX S.

CANVASS OF BIDS, SEPTEMBER 8, 1896, SECTION 10, SUBWAY.

BIDDERS AND ADDRESSES.	4,500 cu. yds. earth excav. below el. 111 for H. street Sq. station.	7,000 cu. yds. earth excav. below el. 111 for H. street Sq. station.	14,000 cu. yds. earth excav. below el. 111 for H. street Sq. station.	600 tons iron and steel work set in place and secured.	300 cu. yds. brick masonry, Rosedale cement mortar.	600 cu. yds. brick masonry, Portland cement mortar.	500 cu. yds. con- crete masonry, American cement mortar.	4,000 cu. yds. con- crete masonry, Portland cement mortar.	35 cu. yds. granite footing-stones.	600 sq. yds. tiling for ceiling of subway walls.	9,000 sq. yds. Portland cement mortar.	9,600 sq. yds. waterproof coating.	TOTALS.
	a	aa	3a	d	e	ee	f	ff	j	p	q	t	
W. H. Keyes & Co., 17 Otis st., Boston.	\$2 50 11,250 00	\$5 50 24,500 00	\$6 00 70,000 00	\$11 00 7,500 00	\$14 00 1,400 00	\$16 00 9,600 00	\$7 25 3,625 00	\$9 50 38,000 00	\$40 00 1,400 00	\$2 00 1,200 00	\$0 50 4,500 00	\$0 50 4,750 00	\$17,815 00
Metropolitan Construction Co., Milk st., Boston.	1 58 7,110 00	3 43 24,010 00	2 28 31,920 00	10 00 6,000 00	16 00 1,500 00	17 60 10,500 00	6 25 3,125 00	9 25 37,000 00	35 00 1,225 00	1 50 900 00	0 50 4,500 00	0 50 4,750 00	133,440 00
Aab & Co., 53 Tremont st., Boston.	2 96 13,275 00	1 86 13,020 00	1 87 26,180 00	7 12 4,912 89	13 00 1,300 00	14 63 8,778 09	6 10 2,550 60	9 20 36,800 00	25 00 875 00	1 00 600 00	0 45 4,050 00	0 50 4,750 00	117,099 80
Steward & McDermott, New York.	1 00 4,000 00	1 63 11,350 00	2 00 28,000 00	10 00 6,000 00	13 50 1,350 00	16 60 9,000 00	6 60 3,250 00	8 15 32,600 00	30 00 1,050 00	0 75 450 00	0 50 4,000 00	0 35 3,325 00	107,375 00
Shaller & Schoenigau Co., Chicago, Ill.	0 90 4,050 00	0 90 6,300 00	0 90 12,600 00	7 50 5,175 00	13 50 1,350 00	14 50 9,700 00	5 50 2,750 00	7 50 30,000 00	26 00 910 00	0 85 510 00	0 30 2,700 00	0 25 2,875 00	77,420 00

APPENDIX T.

CANVASS OF BIDS FOR STEEL, SECTION 11, SUBWAY,
JULY 29, 1897.

BIDDERS AND ADDRESSES.	ABOUT 330 TONS.	
	Price per ton.	Totals.
Boston Bridge Works, 70 Kilby st., Boston, Mass...	\$45 71	\$15,084 30
A. & P. Roberts Co., Philadelphia, Pa.....	42 00	13,860 00
The Carnegie Steel Company, L'd, 125 Milk st., Boston, Mass.....	40 24	13,279 20
Passaic Rolling Mill Company, Paterson, N.J.....	39 28	12,962 40
New Jersey Steel & Iron Company, Trenton, N.J. .	34 20	11,286 00

FRAGILE
DO NOT
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